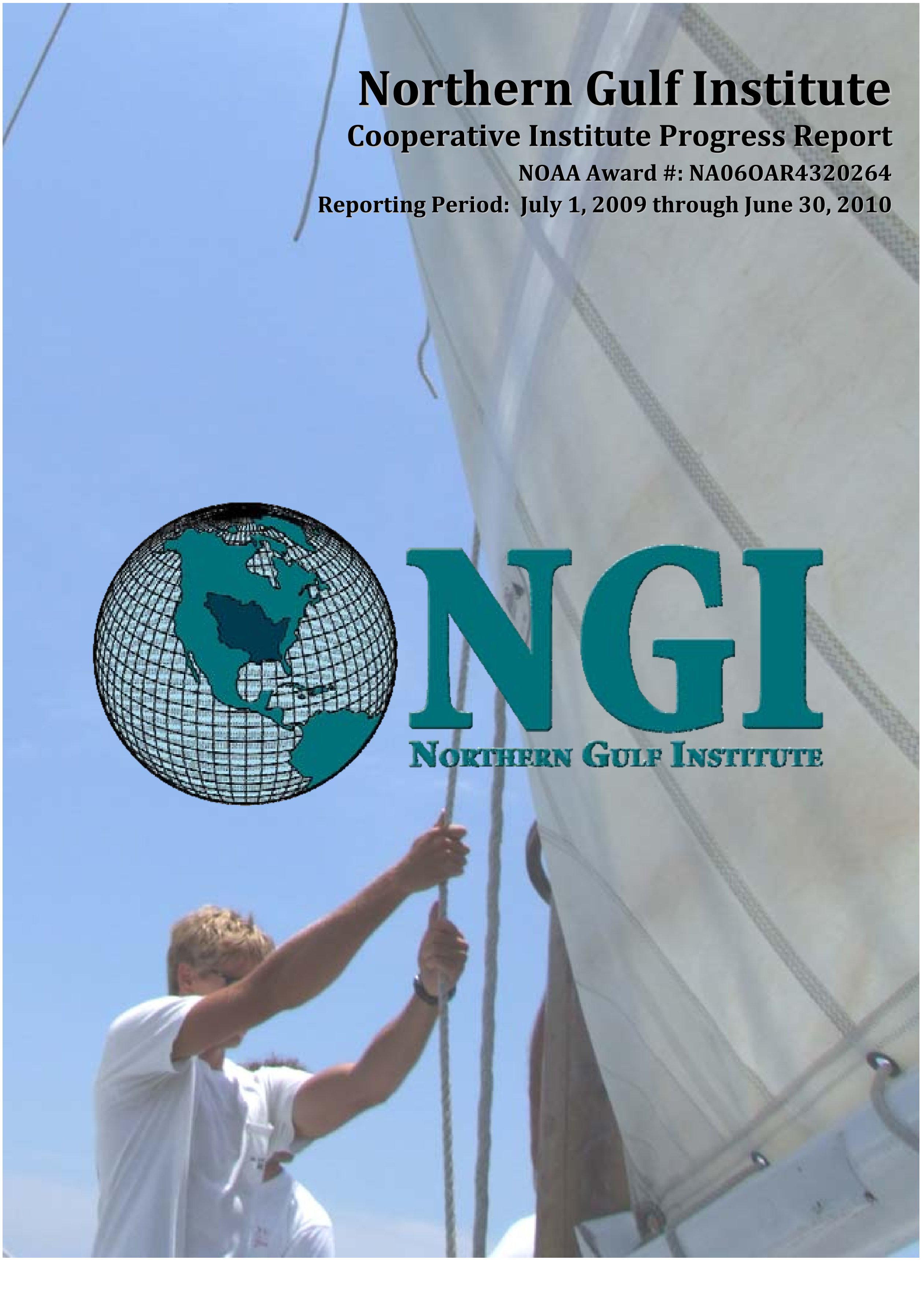
Northern Gulf Institute

Cooperative Institute Progress Report

NOAA Award #: NA06OAR4320264

Reporting Period: July 1, 2009 through June 30, 2010



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EXECUTIVE SUMMARY

Northern Gulf Institute Progress from July 1, 2009 to June 30, 2010

The Northern Gulf Institute (NGI) is a National Oceanic and Atmospheric Administration (NOAA) Cooperative Institute, a partnership of five complementary academic institutions and NOAA addressing important national strategic research and education goals. Mississippi State University leads this collaboration, partnering with the University of Southern Mississippi, Louisiana State University, Florida State University, Alabama's Dauphin Island Sea Lab, and NOAA scientists at various laboratories and operational centers in the northern Gulf of Mexico region.

NGI was recognized by the NOAA Cooperative Institute Science Review Panel for its significant efforts to address important questions related to the NOAA Strategic Goals. NGI develops, operates, and maintains an increasingly integrated research and transition program, the results of which raise awareness and understanding of the Gulf region and fill priority gaps in and decision support in the region. During this progress reporting period, NGI completed its 5 Year Science and Administrative Review and received an "Outstanding" rating from the independent Science Review Panel. NGI has been recognized as critical and well positioned to provide baseline, current, and future science and outreach needs to the region. Such a role for NGI is even more important in the wake of the April 20, 2010 Deepwater Horizon Incident.

Figure 1. Students collect samples in their study of the marine ecosystem of the Big Bend Region

The Institute contributes to NOAA's priority interests in the four NGI research themes of Ecosystem Management, Geospatial Data Integration and Visualization, Coastal Hazards, and Climate Effects on Regional Ecosystems. Important recent research accomplishments focus on the issues and resources of the Gulf, but the tools and protocols are transferrable to other coastal environs. Selected examples of these successes follow.

1. Integrated studies improved the understanding of the life cycle and habitats of the gag grouper (*Mycteroperca microlepis*), a major commercial and game fish in the Big Bend region of Florida. Lagrangian particle tracking methods revealed that larvae released from known spawning sites in the late winter/early spring time period can potentially reach the submerged aquatic vegetation beds within a two-month time frame if they remain near the ocean bottom. Significant variability in the fate of the simulated larvae strongly correlate with the synoptic scale atmospheric forcing.
2. Working to establish the relationship between sediments and mercury in the Mobile Bay system, NGI hosted a regional mercury workshop that resulted in a regional coordinated data collection effort with participation of all of the Mobile Bay mercury research activities. Significant results from the project include: the determination of the first watershed inputs of methylmercury to Mobile Bay, the finding that upstream or marginal areas with adjacent wetlands such as Weeks Bay and the Delta appear to be sites of net mercury methylation, and the resulting hypothesis that similar areas in the Gulf of Mexico will likewise be higher in mercury levels.

3. Mississippi River freshwater diversions have a major impact on sensitive coastal ecosystems. NGI studies have led to a greater understanding of the impact of these fresh water diversions and their increased sediment loads and to a scientifically controlled decision process on the use of fresh water diversions.
4. NGI funding also led to the development of inexpensive living shoreline restoration approaches that have already been adopted by state government and Nature Conservancy coast line restoration efforts.
5. The NOAA National Coastal Data Development Center led a collaboration of a transferable Integrated Ecosystem Assessment protocol using the NGI Ecosystem Data Assembly Center (EDAC). Using this NGI data management system, Department of Defense imagery and ocean model outputs are now available historically or in near real-time to researchers. EDAC provides the Navy global and Gulf of Mexico ocean model data accessed by the U. S. Coast Guard in their operational environmental data server for both research and operational search and rescue operations.
6. NGI, working closely with the NOAA Gulf of Mexico Regional Collaboration Team, has hosted two workshops on Integrated Ecosystem Assessments and developed a multi-university team to produce a prototype Integrated Ecosystem Assessment. NGI will lead the follow-on Ecosystem Approach to Management project, starting in the next progress reporting period.
7. NGI is the NOAA co-lead in the development and testing of the Weather In-Situ Deployment Optimization Method wind current tracking research balloons. NGI is also the Gulf of Mexico Test bed for NOAA Unmanned Aircraft System development. It hosted the NOAA UAS Planning Workshop and has been working closely with the NOAA UAS program manager in developing operational alternatives for Gulf of Mexico, Arctic, and Pacific operations. These alternatives will form the basis for decision making concerning NOAA UAS operation issues. Data from the research balloons and unmanned aircraft will be use to improve predictions of hurricane landfall and intensity. NGI has developed the protocols and led the training for the WISDOM balloon launch teams.
8. An important NGI and Gulf of Mexico Alliance priority, resilient coastal communities, was enhanced by NGI research on a revised Saffir Simpson scale. The new scale, based on tropical cyclone size, intensity, storm speed, and continental shelf slope/depth was completed. The new scale accounts for all surge factors and will help coastal residents and planners better appreciate risks associated with hurricane storm surge.
9. NGI researchers completed 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. Regions with low salinity impacted by outflow of the Mississippi river were found to be year-round CO_2 sinks. This is attributed to the large nutrient loads and resulting enhanced biological productivity in this region.

The NGI Education and Outreach office continues to develop its comprehensive integrated programs. Its goals of environmental education and NOAA workforce development bridge NGI research and facilitate the transition of NGI research to NOAA operational centers and to the public. The program links students at NGI universities to NOAA with career fair participation, minority internships and project employment opportunities.

Based on the recommendation by the Science Review Panel, the NGI leadership team is developing the next generation NGI Strategic Plan with the input from its university and NOAA partners. In response to the NOAA Administrative Review, the Program Office is developing a handbook for NGI researchers. The NGI Program Office strives to make the complex collaborations as efficient and easy as possible for the participants. Current efforts include development of an online proposal and reporting system.

The NGI Program Office's strategic location at the Stennis Space Center, MS, facilitates close interactions with several NOAA activities and key stakeholder groups such as the NOAA Gulf of Mexico Regional Collaboration Team, Sea Grant programs in the region, and the Gulf of Mexico Alliance. NGI has enhanced the opportunities for broadening its geographic focus area through collaboration with the Harte Research Institute (located at Texas A & M University, Corpus Christi) by entering into a memorandum of understanding during this reporting period. This partnership has already resulted in a new Ecosystem Approach to Management initiative that includes work across all five states bordering the Gulf. With the recent groundbreaking for the Mississippi State University Science and Technology Center at Stennis Space Center which will house NGI and NOAA activities, NGI has the foundation and the building blocks to maintain and grow its role in northern Gulf of Mexico environmental research and education.

Since its initial award on October 1, 2006, the NGI's leadership has worked diligently to build collaborations between the five academic institutions and NOAA research and education programs. The initial base funded research projects are mature or complete, and a new slate of projects began in NGI Year 4. In addition to the base funded research, an increasing number of individual awards enhance the NGI program, and their progress is also reported here. NGI activities during this progress reporting period total $8,475,470 of NOAA support. NGI continues to use this NOAA investment to contribute to the recovery and future health, safety, resilience and productivity of the Northern Gulf of Mexico region, through sustained research and applications in a geospatial and ecosystem context. This progress report describes the NGI organization and operations of the NGI program and the results of each research and education and outreach effort. NOAA cooperative institute metrics summarizing published research and staffing support are provided in the appendices.

PART 1 – PROGRAM OVERVIEW

Introduction

This NGI Annual Progress Report reviews and summarizes the research and the education and outreach goals accomplished during the reporting period of July 1, 2009 to June 30, 2010. The report consists of two (2) sections and appendices. Part 1 - Program Overview, provides the General Description of NGI, the NGI Direction, Organization and Operations, NGI Research Focus Areas and Highlights, and Distribution of funding to NGI from NOAA. Part 2 begins with the list of all of the awards to the NGI with projects currently active. The Performance of Projects section details both base-funded projects and individually awarded projects. The reporting elements outlined in the July 8, 2010 memo from NOAA OAR. Appendix A provides the total count of publications for this reporting period, and Appendix B summarizes the total number of employees and students supported by NOAA funding at NGI. A list of all figures in this report appears in Appendix C.

General Description of the Northern Gulf Institute

The Northern Gulf Institute is a NOAA Cooperative Institute, a partnership of five complementary academic institutions and NOAA. The collaboration is led by Mississippi State University partnering with the University of Southern Mississippi, Louisiana State University, Florida State University, and the Dauphin Island Sea Lab 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, consisting 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 NOAA led research began in the spring of 2006 and research initiatives at the NGI partner institutions began in February 2007.

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, with a new slate of projects started in year 4. This progress report reflects the final reports for the initial 3-year projects, and progress to date on year 4 projects. In addition to the base funded research, several individually awarded activities are underway, and their progress is also reported herein. NGI activities during this progress reporting period totaled $8,475,470.

The NGI Education and Outreach office continues to develop comprehensive integrated programs to educate the public on NGI research and to facilitate the transition of NGI research to NOAA operational centers. The program bridges universities to NOAA with career fair participation, minority internships and student employment. NGI works 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 messaging campaign to address identified priority issues. More details are provided in Part 2 under the NGI education related projects.

The overall goal of the NGI research is transition to NOAA operations and, ultimately, to stakeholder 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).

NGI Direction, Organization and Operations

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

Organization and Operations

Figure 2 illustrates the NGI organizational structure and collaborative connections. The top row reflects the oversight role of MSU. The interim Director of NGI, who reports to the MSU Vice President for Research, maintains an office on the MSU campus and at Stennis Space Center, MS. The NGI MSU campus based office is led by a tenured faculty member. The Director's 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. At the direction of the Director, the NGI Co-Director assists in this role.

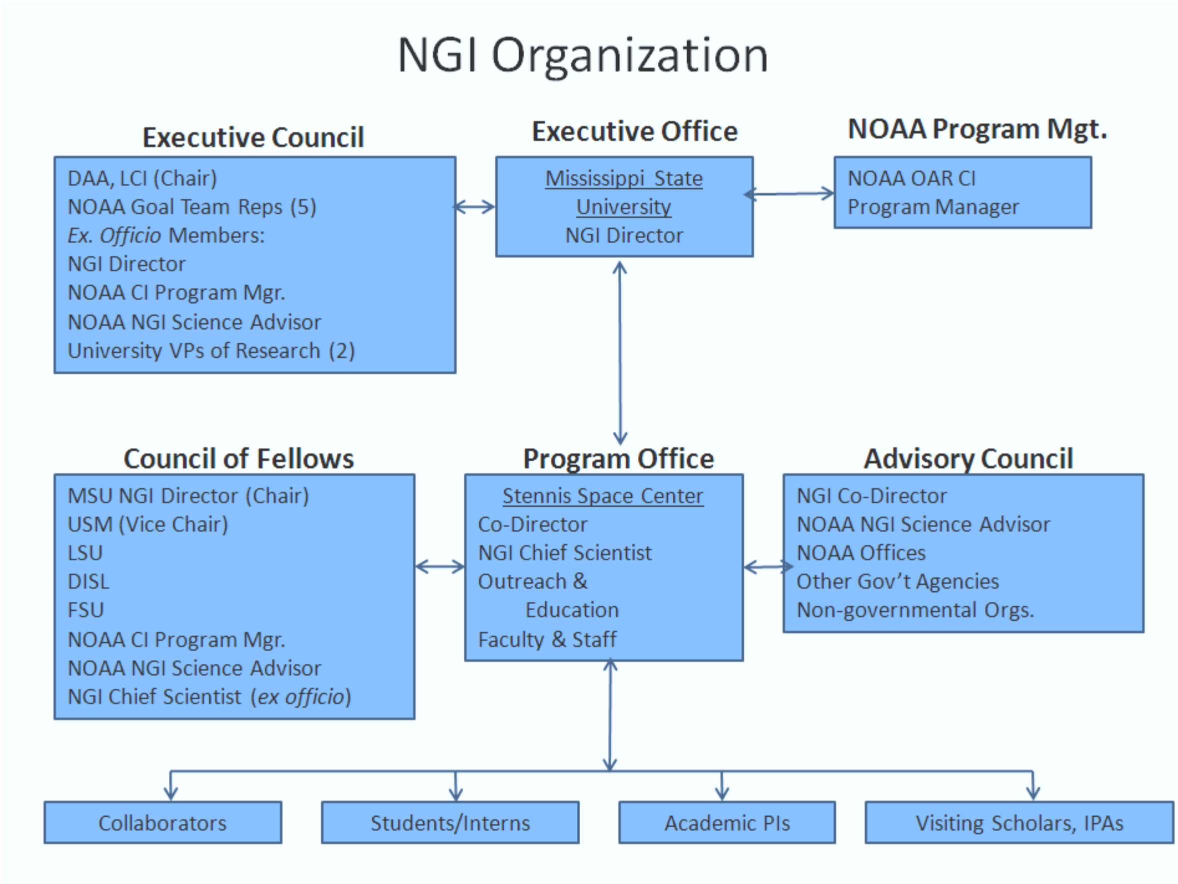

Figure 2. NGI Organization Diagram

NGI program operations and implementation is guided by the NOAA October 1, 2006 award and subsequent awards, adoption of a Memorandum of Agreement between MSU and NOAA, and compliance with the NOAA Cooperative Institute Interim Handbook. The NGI Strategic Plan and NGI Implementation Plan provide the road maps for planning and operations of the Institute. In accord with recommendations from the Science Panel of the Cooperative Institute Five Year Review, NGI Program Office is currently shepherding the revision to the first strategic plan. The Executive Office and Program Office staff coordinate with the NOAA Office of Oceanic and Atmospheric Research amendments to the original award which support research and education by NGI in support of activities of 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 guides communications with NOAA's CI Program, participating NOAA offices, and the various review, advisory and working-level entities affiliated with NGI. The NGI Program Office located at the Stennis Space Center, Mississippi, is staffed by the MSU employees at Stennis, including research and outreach faculty and the NGI Chief Scientist. The Program Office is responsible for maintaining regular interaction with the

Council of Fellows, the NGI Advisory Council, and the NOAA NGI Science Coordinator. NGI participates in the NOAA Gulf of Mexico Regional Collaboration Team. It also has prime responsibility for the day-to-day management of the Institute that includes proposal processing and project management, facilitating meetings of the Council of Fellows, the NGI Annual Conference, and NGI students, contractors and visiting scholars on-site at Stennis. During this reporting period the Program Office supported Lisa Parker (USM public affairs masters program), and two undergraduate students, Devon Bise (MSU undergraduate in Geosciences) and Will Whitfiled (MSU undergraduate in aerospace engineering). As the Program Office matures, it constantly upgrades services to the research and education affiliates, and applies adaptive management approaches to improved central funding and program stewardship.

NGI 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 Coordinator, and the NOAA OAR CI Program Manager. At the direction of the NGI Director, the Council is chaired by the NGI Co-Director. 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 II 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:

William McAnally, Ph.D., Mississippi State University (chair)
Steven Lohrenz, Ph.D., University of Southern Mississippi
Eric Chassignet, Ph.D., Florida State University
Chris D'Elia, Ph.D., Louisiana State University
George Crozier, Ph.D., Dauphin Island Sea Lab

Meetings of the NGI Council of Fellows for this reporting period were held on December 14-15, 2009 at Dauphin Island Sea Lab, and in conjunction with the NGI Annual Conference in May 18 and 20, 2010 in Mobile, Alabama. At the May meeting, the Council of Fellows and the Advisory Council held a joint session to allow exchange of recommendations from the Advisory Council and updates on progress from the Fellows. The Fellows held several planning teleconferences in advance of the NGI 5 Year Review. Conference calls of the NGI Council of Fellows regarding the 5 Year Review and on other matters for this reporting period were held September 8, October 5, and November 17, 2009.

NGI Executive Council

The Executive Council consists 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 Coordinator, the NGI Director, and the NOAA OAR Cooperative Institute Program Manager serve as ex officio members of the Executive Council.

The Executive Council is primarily responsible for broad policy and program direction for the NGI. The Council plans to 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, however it has not met during this reporting period. 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 committed to transparency, accountability, governance control, and effective integration through the Executive Council. The NGI Executive Council consists of:

Bonnie Ponwith, Ph.D., Director, NOAA SE Fisheries Science Center (Chair)
Gary M. Carter, Director, Office of Hydrologic Development
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
David Shaw, Ph.D., VP for Research & Econ. Dev., Mississippi State University
Denis Wiesenburg, Ph.D., VP for Research, University of Southern Mississippi
John Cortinas, Ph.D., OAR CI Program Manager (Special Advisor, Ex-officio)
Mike Carron, Ph.D., NGI Interim Director (Ex-officio)

NGI 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 they identify the need. The NGI Advisory Council members are:

Julien Lartigue, Ph.D., NOAA NGI Science Coordinator
Russ Beard, NOAA National Coastal Data Development Center
Miles Croom, NOAA-National Marine Fisheries Service
Todd Davison, NOAA Gulf Coast Services Center
Kristen Fletcher, Coastal States Organization
Bryon Griffith, EPA Gulf of Mexico Program
Judy Haner, The Nature Conservancy
Karl Havens, Ph.D., Florida Sea Grant College Program
Dawn Lavoie, Ph.D., USGS Gulf Coast & LMV
Kathleen O'Neil, NOAA National Data Buoy Center
Ann Peek, ARTPO, NASA Stennis Space Center
David Reed, NOAA National Weather Service LMRFC
Mathias Romkens, USDA National Sedimentation Lab
David Ruple, Grand Bay National Estuarine Research Reserve
Martha Segura, NPS Gulf Coast Network
LaDon Swann, Ph.D., MS-AL Sea Grant Consortium
William Walker, Ph.D., MS Department of Marine Resources
Jeff Waters, US Army Corps of Engineers
Chuck Wilson, Ph.D., Louisiana Sea Grant College
William McAnally, Ph.D., MSU/NGI Co-Director (Chair)

The Advisory Council met on October 30, 2009 (in Biloxi, MS) and May 20, 2010 (Mobile, AL) to assess NGI research directions and advise the Fellows on important issues facing the region.

NGI Research Focus Areas

During this reporting period the first academic partner led projects approached maturity or conclusion. The Institute contributes to NOAA's priority interests in four NGI research themes of Ecosystem Management, Geospatial Data Integration and Visualization, Coastal Hazards, and Climate Effects on Regional Ecosystems. Several examples of benefits and research highlights follow the descriptions of each theme.

Ecosystem Management

The ecosystems in the northern Gulf are the home to valuable fisheries, important recreational activities, and many commercial operations including fossil fuel extraction and coastal industries. The region needs more monitoring and basic information to support resource management. Fisheries ecosystem based management is a fundamental element in NOAA's Five Year Strategic Plan and a recommendation of the President's Commission on Ocean Policy as part of an overall strategy to protect, preserve, and utilize our marine resources.

Theme Research Objectives

1. Monitoring and assessment of coastal marine ecosystems in the northern Gulf
2. Ecosystem-based fisheries management
3. Circulation modeling and observations for ecosystem management
4. Coastal ecosystem resiliency

Figure 3. Student measures sediment accumulation and erosion in the shallow-water of a Louisiana wetland.

Approach: A balanced mix of wide and narrow-focused research projects makes up the collection of work under the Ecosystems management theme. From the wetland marshes of Louisiana to the white-sand beaches of the Florida panhandle, the northern Gulf of Mexico showcases a range of coastal ecosystems. Each ecosystem presents new challenges for researchers working to understand the dynamic interplay between inland and Gulf habitats. NGI partners bring their background in use of modern scientific tools, a long history of developing knowledge about the fundamental processes forming coastal and deltaic environments, and extensive experience working with the public, resource managers, and policy makers on issues of significant importance to management at local, regional, and national levels. As NGI capacity, collaborations and research resources build, upland components of the Gulf ecosystem will be included.

Geospatial Data Integration and Visualization

The ability to assess the distribution of features in the coastal environment has improved dramatically over recent decades. Many organizations are involved in collecting data to measure the primary properties of coastal zones using a variety of methods ranging from remote sensing to in situ sensors and sampling. There is a wealth of accumulated information about coastal zones in various databases, files, spreadsheets. Sharing generated datasets, information, and results between geographically distributed organizations often proves to be challenging. Further, use of higher resolution data has been limited because of the computational intensity required.

Theme Research Objectives

1. Geospatial assessment and strategic planning
2. Semantics-driven framework for understanding coastal/ocean data
3. Visualization technologies
4. Improvements to coastal mapping methodologies

Approach: One word describes this theme – capabilities. Projects under this theme emphasize development of capabilities for resource managers, scientists, and citizens. NGI partners provide capabilities in remote sensing, computational technologies, visualization techniques, natural resource management, and the transition of these into operational agency research, planning, and decision-support programs. The end-to-end approach involves a strong geospatial extension program in the development and execution of research programs with the end-user in mind at each step.

Coastal Hazards

Improving understanding of several significant coastal hazards is more crucial now than ever before. Coastal populations have grown exponentially over the past 30 years. In addition, the Gulf of Mexico is one of the most economically critical ecosystems in the Nation. Coastal hazards and public health and safety are major concerns to agencies responsible for the public good of coastal regions. Weather and ocean phenomena considered in the context of anthropogenic factors pose considerable resource sustainability, financial and safety threats to the Gulf coast region.

Theme Research Objectives

1. Forecasting and valuing catastrophic natural events to coastal communities
2. Assessment of localized hypoxia in shelf waters
3. Address issues of oceans and public health
4. Economic assessment of coastal hazards

Approach: Several academic and research units explore the susceptibility of the Northern Gulf of Mexico to changes and risks of living and working in the coastal zone from cyclones, contaminants, climate change, and water resource issues. Innovative research in risk analysis and management, policy development, economic and community development, and natural resource economics is an important strength of NGI partners. A variety of research and academic units focused on coastal science and engineering and new approaches in dynamically developed system analysis enables integration of ecosystem restoration programs in concert with naturally occurring coastal disturbances.

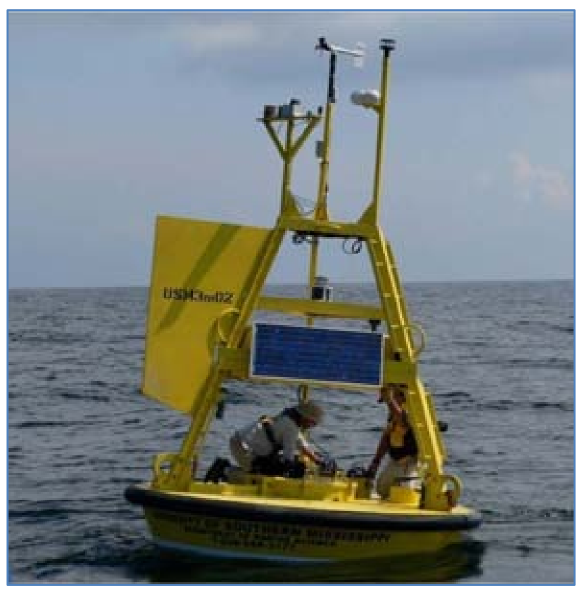

Figure 4. Mississippi researchers equip an ocean buoy with data collection equipment.

Climate Effects on Regional Ecosystems

NOAA believes that the nation needs targeted climate services at all scales and that this goal will require unprecedented levels of coordination between all agencies. Within the US, extensive climate-related changes have been documented. In the 2001 Southeast Regional Climate Assessment Study sponsored by NASA, the southeastern U.S. was the only region for which climate models simulated large and opposing changes in precipitation patterns over the next 100 years. The range of differences was so great that it was difficult to state with any degree of confidence that precipitation will increase or decrease in the Southeast over the next 30 to 100 years as atmospheric CO_2 and other greenhouse gases increase. A highly developed global model with an embedded high resolution regional model is expected to provide more accurate site- and year-specific predictions of maximum and minimum temperature, precipitation frequency and amount, and net radiation than forecasts based on historic or El Nino Southern Oscillation climatology.

Theme Research Objectives

1. Impact of regional climate variability on watersheds and coastal activity
2. Explore the impacts of event-scale forcing linked with climate variability
3. Examine climate change impacts to fisheries ecosystems

Approach: Deployment of successful monitoring systems and highly sophisticated data analysis are just two of the strengths NGI has brought to bear on this theme. The collaboration between partners has created a synergistic approach to collecting data for climate model inputs and model interpretation. Effective climate models contribute to a better understanding of the northern Gulf of Mexico ecosystems and how they are affected by climate change.

Research Highlights

Important recent research accomplishments focus on the issues and resources of the Gulf, but the tools and protocols are transferrable to other coastal environs. Here are a few examples of these successes.

Integrated studies improved the understanding of the life cycle and habitats of the gag grouper (*Mycteroperca microlepis*), a major commercial and game fish in the Big Bend region of Florida. Lagrangian particle tracking methods revealed that larvae released from known spawning sites in the late winter/early spring time period can potentially reach the submerged aquatic vegetation beds within a two-month time frame if they remain near the ocean bottom. Significant variability in the fate of the particles strongly correlates with the synoptic scale atmospheric forcing.

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NGI, working closely with the NOAA Gulf of Mexico Regional Collaboration Team has hosted two workshops on Integrated Ecosystem Assessments and developed a multi-university team to produce a prototype Integrated Ecosystem Assessment. NGI will lead the follow-on Ecosystem Approach to Management project, starting in the next progress reporting period.

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Distribution of Funding Support to NGI from NOAA

Total NOAA funding support awarded to NGI during the progress reporting period was $8,475,470. This section contains charts that illustrate the distribution of funding support levels by cooperative institute tasks, by distribution of activities within Task 1 with description of the activities, and by NGI Research theme area.

Distribution of NGI Funding Support by Cooperative Institute Task Category

A summary of NGI funding distribution by the three cooperative institute task categories is shown in the chart and detailed in Table 1.

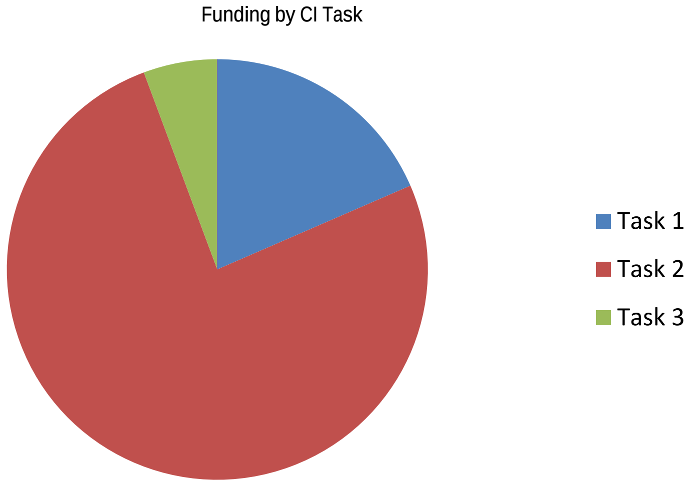
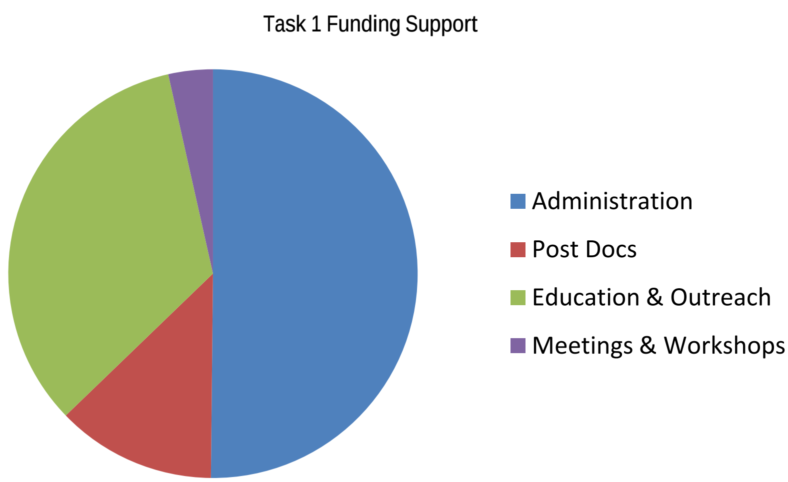


Table 1. Summary of NGI funding distribution by the three cooperative institute task categories.

Funding by CI Task	*Task 1 – Admin, Ed & Outreach, Post Doc, Meetings*	*Task 2 – Collaborate closely with NOAA Scientists*	*Task 3 – Mostly independent of NOAA Scientists*
NGI Year 4	$1,565,293	$6,428,993	$481,184

Distribution of NGI Task 1 Funding Support



NGI TASK 1 Activity	Funding	% of Total
Administration	$785,236	50%
Post Docs	$197,554	13%
Education and Outreach	$527,503	33%
Meetings and Workshops	$55,000	04%
Total	$1,565,293	100%

Task 1 funding supports the central management and coordination of the five complementary universities working together with NOAA. It also supports several post-docs and education and outreach efforts, including internships and translating the research results for general dissemination and use in teacher workshops. Details of these efforts at are reported in project reports of 06-DISL-01, 06-MSU-08 and 09-NGI-17. NGI hosts an annual conference to bring together researchers, students, stakeholders, the NGI Advisory Council and NOAA to highlight the research progress and help foster the collaborations that have led to NGI's position as a leading regional research institution.

Funding by NGI Theme

NGI activities address one or more of the four NGI Research Themes for projects with funding awarded during this reporting period. The funding for projects with more than one primary theme was divided into the themes. A summary of funding support for research by NGI Theme is shown in the chart and detailed in Table 2.

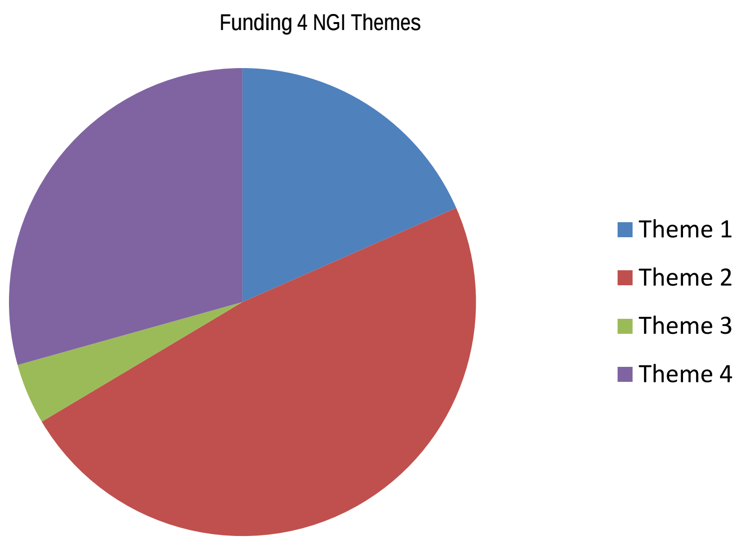


Table 2. Summary of funding support for research by NGI Theme.

4 NGI Themes	*Theme 1*	*Theme 2*	*Theme 3*	*Theme 4*
NGI Year 4	$1,387,000	$3,621,089	$316,702	$2,210,533

- Theme 1 – Ecosystem Management
- Theme 2 – Geospatial Data and Visualization
- Theme 3 – Climate Change Impacts
- Theme 4 – Coastal Hazards and Resiliency

PART 2 – PERFORMANCE OF PROJECTS

List of NOAA Awards to NGI with Currently Active Projects

NAOAR062340264	PROJECTS			
NOAA Amendment #	NGI File #	Project Title	Start	End
NGI Yr 1-3 Base Funded Projects -- supported under the original NGI award and Amendments # 03 & 14.*	06-DISL-01	Marine Education and Outreach at the Dauphin Island Sea Lab - Dindo	2.01.07	1.31.10
	06-DISL-02	Restoring estuarine landscapes in Alabama coastal waters through creation of oyster reefs - Heck	2.01.07	1.31.10
	06-FSU-01	Integrated Research for Northeast Gulf of Mexico Big Bend Region - Chassignet	2.01.07	1.31.10
	06-LSU-01	DELTA Ecosystem Forecasting System - Justic	2.01.07	1.31.10
	06-LSU-02	Public Health and Stressors - Ates	2.01.07	1.31.10
	06-LSU-03	Trophic Linkages and Biomass Production in Estuarine Ecosystems - Sutor	2.01.07	1.31.10
	06-LSU-04	Investigating Material Exchange Between the Marsh and Channel Along an Estuarine Gradient - Cable	2.01.07	1.31.10
	06-MSU-01	Developing a Foundation for Analysis of Natural and Human-Induced Disturbances to Coastal Economies - Petrolia	2.01.07	1.31.10
	06-MSU-02	Assessing the Impact of Ordinances, Outreach and Enforcement on the Resiliency of Gulf Coastal Watersheds - Walker	2.01.07	1.31.10
	06-MSU-03	Watershed Modeling Improvements to Enhance Coastal Ecosystems - McAnally	2.01.07	1.31.10
	06-MSU-04	Spatial Technology and High Performance Computing for Improving Prediction of Surface Water Quality - McAnally	2.01.07	1.31.10
	06-MSU-05	Modeling Mobile Bay Sediments and Pollutants with New Technologies - McAnally	2.01.07	1.31.10
	06-MSU-06	Visualization Techniques for Improving Public Understanding of Catastrophic Events - Moorhead	2.01.07	1.31.10
	06-MSU-07	An Information Semantic Approach for Resource and Knowledge Discovery in an Integrated Ocean Observing System - King	2.01.07	1.31.10
	06-MSU-08	Northern Gulf Institute Outreach Efforts - Hodge	2.01.07	1.31.10
	06-MSU-09	Improving Hurricane Intensity and Landfall Estimation with Refined Modeling - Fitzpatrick	2.01.07	1.31.10
	06-USM-01	Microbial Source Tracking and its Application to the Northern Gulf of Mexico - Ellender	2.01.07	1.31.10
	06-USM-02	Utility of Ionosphere and Troposphere Models for Extending the Range of High-Accuracy GPS - Dodd	2.01.07	1.31.10
	06-USM-03	Monitoring and Assessment of Coastal and Marine Ecosystems in the Northern Gulf - Howden	2.01.07	1.31.10
	06-USM-04	Interaction Between Off-shore Circulation and Nearshore Processes During Extreme Weather Events - Kamenkovich	2.01.07	1.31.10
	06-USM-05	Satellite and in situ Optical Assessment of Algal Bloom Events in the Northern Gulf of Mexico - Lohrenz	2.01.07	1.31.10
	06-USM-06	Coordination and Educational Support for USM Northern Gulf Institute Activities - Lohrenz	2.01.07	1.31.10
	06-USM-07	Quantifying Ecosystem Services of Different Coastal Habitat Types - Fulford	2.01.07	1.31.10
	06-USM-08	Macrofaunal Indicators of Hypoxia - Rakocinski	2.01.07	1.31.10
Amendment # 12*	08-MOD-12	Development of Prototype Integrated Ecosystem Assessments in the Northern Gulf of Mexico - Carron	7.01.08	9.30.09
Amendment # 13*	08-MOD-13	NOAA Coastal Storms Program - ADCIRC (Storm Surge) Grid Cataloging Project - Carron	7.01.08	9.30.09
Amendment # 15*	08-MOD-15	The Mississippi Digital Earth Model - Samson	8.01.08	7.31.09
Amendment # 16*	09-MOD-16	Air Monitoring and Analysis at the Grand Bay National Estuary Research Reserve - Carron/Ruple	1.01.08	9.30.11
Amendment # 17*	09-MOD-17	NOAA Coastal Services Center - Risk Wise Communities Partnership Workshop - Ritchie	2.01.09	9.30.09
Amendment # 18*	09-MOD-18	Trophic Support of Fishery Production in Salt Marshes related to Tidal Inundation Patterns	4.01.09	9.30.09
Amendment # 19	09-MOD-19	Optimizing the Use of Lightning Data in Severe Storm Warning Assessment - Year 2 - Carron	8.01.09	7.31.10
Amendment # 20*	09-MOD-20	NOAA/NGI Minority Summer 2009 Internship Program - Ritchie	5.01.09	8.30.09
Amendment # 21	09-MOD-21	NOAA/NGI 2009 Mississippi Water Resources Conference Student Travel Program - Ritchie	7.01.09	8.31.09

Amendment # 22	09-MOD-22	Advanced Data Assimilation Experiments for GOES-R Series Applications - Shaw	10.01.09	9.30.11
Amendment # 23	09-MOD-23	NGI Sustained Operations Alternatives - Shaw/Case	7.01.09	6.30.10
Amendment # 24	09-MOD-24	NGI Coastal Storms Program - NOAA Unstructured Grid Cataloguing Project - Year 2 - Carron	7.01.09	6.30.10
Amendment # 25*	09-MOD-25	Program Management and Systems Engineering and Integration Support to the NOAA Unmanned Aircraft Systems Program - Shaw	6.01.09	2.28.10
Amendment # 26	09-MOD-26	Balloon and Payload Acquisition for WISDOM Activities during the 2009 Hurricane Season - Shaw	7.01.09	6.30.10
Amendment # 27	09-MOD-27	Amoeba-Net Testing Advanced Network Capabilities Using GeoFish and OceanNOMADS - Carron	7.01.09	12.31.09
Amendment # 28	09-MOD-28	NGI and NCDDC Hyperspectral Imagery Support to the GOMA Habitat Project for Grand Bay NERR - Harding	7.01.09	12.31.09
Amendment # 29	09-MOD-29	Development of a Northern Gulf of Mexico Operational Forecast System - Carron/Chen	7.01.09	12.30.10
Amendment # 30	09-MOD-30	2009 Summer Internship for the NGI Ecosystem Data Assembly Center - Ritchie	6.01.09	8.31.09
Amendment # 31	09-MOD-31	The Mississippi Digital Earth Model - Samson	8.01.09	7.31.10
Amendment # 33	09-MOD-33	NGI Support for Gulf of Mexico Alliance 2009 Governors' Action Plan Implementation and Integration Workshop - Carron	7.01.09	12.31.09
NGI Yr 4 Base Funded Projects 09-NGI-xx projects were awarded funding under Amendment # 32 (except 09-NGI-12 & 09-NGI-16 which had support directly from NOAA to the NOAA PIs, not through NGI).	09-NGI-01	Developing a Tool for Assessing Cost Effective Best Management Practices for Resilient Communities - Wilkerson	10.01.09	9.30.10
	09-NGI-02	From Physics to Fish: Modeling the Effects of Pulsed River Diversion on Fish Distribution - Justic	10.01.09	9.30.10
	09-NGI-03	Riverine and Estuarine Carbon Export to the Coastal Ocean, Northern Gulf of Mexico - Fry	10.01.09	9.30.10
	09-NGI-04	Spatial Variation and Temporal Trend of Water Quality in the northern Gulf of Mexico - Lee	10.01.09	9.30.10
	09-NGI-05	Sediment and Mercury Path and Fate Modeling - McAnally	10.01.09	9.30.10
	09-NGI-06	Toward an Understanding of Gulf Coast Resident Preferences and Perceptions on Risk and Restoration - Petrolia	10.01.09	9.30.10
	09-NGI-07	Food webs without borders: a case for ecosystem-based management in the northern Gulf of Mexico - Valentine	10.01.09	9.30.10
	09-NGI-08	Understanding Coastal Resiliency from Hurricane Impacts Using Integrated Modeling and Observations - Chen	10.01.09	9.30.10
	09-NGI-09	Visual Analytics for Assessment and Interpretation of Simulated River Flooding - Amburn	10.01.09	9.30.10
	09-NGI-10	Climate-related ichthyofaunal shifts in the northern Gulf of Mexico: implications for estuarine ecology and nearshore fisheries - Heck	10.01.09	9.30.10
	09-NGI-11	Identifying linkages between zooplankton dynamics, fishery resources and climate change in the Northern Gulf of Mexico - Lyczkowski-Shultz	10.01.09	9.30.10
	09-NGI-12	Validation and Verification of a Canine Fecal Source Identification -Goodwin	NOAA ONLY	NOAA ONLY
	09-NGI-13	Monitoring and Assessment of Coastal and Marine Ecosystems in the Northern Gulf - Howden	10.01.09	9.30.10
	09-NGI-14	Assessment of ecosystem services of selected coastal habitat types: Towards a model-based toolset for management planning - Fulford	10.01.09	9.30.10
	09-NGI-15	Data Management in Support of NOAA's Integrated Ecosystem Assessment through the NGI Ecosystem Data Assembly Center - Beard	10.01.09	9.30.10
	09-NGI-16	Contrasting high and low relief fishery habitats of the Northeastern Gulf: habitat delineation, food web components and spatial demographics - DeVries	NOAA ONLY	NOAA ONLY
	09-NGI-17	Northern Gulf Institute Integrated Education and Outreach Program - Ritchie	10.01.09	9.30.10
	09-NGI-18	Forecasting Episodic Changes in Hurricane Intensity and Structure over the Gulf of Mexico - Hill	10.01.09	9.30.10
	09-NGI-19	Integrated Research for the Northeast Gulf of Mexico Big Bend Region - Chassignet	10.01.09	9.30.10

* Amendments were awarded prior to this reporting period based on the GrantsOnline award file period.

Research activity was still ongoing and is reported; funding in not included on the distribution charts.

Amendments prior to Amendment # 12 were not active during this reporting period.
Some projects have been granted no cost extensions.

06-MSU-05 is reported with 09-NGI-05

09-NGI-MOD-13 is reported with 09-NGI-MOD-24

09-NGI-MOD-15 is reported with 09-MGI-MOD-31

09-NGI-MOD-23 is reported with 09-NGI-MOD-25

PROJECT 06-DISL-01: MARINE EDUCATION AND OUTREACH AT DAUPHIN ISLAND SEA LAB

1. Project Leads:

Name	*Title*	*Affiliation*	*Email*
John Dindo	PI	Dauphin Island Sea Lab	jdindo@disl.org
Tina Miller-Way	Co-PI	Dauphin Island Sea Lab	tmiller-way@disl.org

2. All Non-Student Personnel funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Tina Miller-Way	Co-PI	PhD	100%	No
Mendel Graeber	Educator	BA	50%	No

3. All Students funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Orrin Robinson	BS	MS	50%	No
Lauren Showalter	BS	MS	50%	No

4. Project Abstract:

Establish a direct link between marine researchers and K-12 marine science education and provide a marine educator to enhance marine science education for school groups and the general public that visit the Estuarium at the Dauphin Island Sea Lab. The Ph.D. researcher/educator assists in bridging the gap between research and K-12 education by interacting with researchers and their projects and educators at the Dauphin Island Sea Lab, the Southern Association of Marine Educators, and the National Marine Educators Association. In addition this person is working closely with the marine educator within the Estuarium to assist in relating marine research to the general public. Included in the messages to the general public through our outreach projects, BayMobile and the Estuarium, will be the priority issues of the Gulf of Mexico Alliance that overlap research efforts by scientists within the Northern Gulf Institute including 1) water quality for healthy beaches and shellfish beds; 2) wetland and coastal conservation and restoration, 3) environmental education, 4) identification and characterization of Gulf habitats and 5) reductions in nutrient inputs to coastal ecosystems.

5. Key Scientific Questions/Technical Issues:

Not applicable for this project.

6. Collaborators/Partners:

Throughout this project, we have worked collaboratively or in partnership with a number of organizations both inside and outside of the northern Gulf of Mexico region. These are delineated below.

National Mississippi River Museum and Aquarium, Yr 3, collaboration with in-kind support, support of interactive kiosk exhibit in Estuarium focused on GOM watershed

Gulf of Mexico Alliance – Environmental Education (GOMA – EE), Yrs 1-3, collaboration with in-kind support, support of social-marketing survey and website development

Centers for Ocean Sciences Education Excellence-Central Gulf of Mexico (National Science Foundation), Yrs 2-3, partnership, support of involvement by NGI scientists in professional development workshop for formal and informal educators

Bay Watershed Education and Training Program (B-WET), Yrs 2-3, collaboration with in-kind support, support of successful proposal development and program implementation at DISL

Mobile Bay National Estuary Program, Yrs 2-3, collaboration with support (exact amount uncertain as EPA GOM project is slightly behind schedule due to the oil spill, in support of 2 ~15 minute videos addressing nutrient inputs and stormwater runoff as well as an associated curricula for educator use

Mississippi-Alabama Sea Grant Consortium, Yrs 1-3, partnership, in support of dissemination of Gulf of Mexico information and issues to students, educators and the public

Alabama Math and Science Technology Initiative (AMSTI), Yrs 1-3, partnership only, recognized as Affiliate member permitting educators to earn certification by participating in our programs

Mobile County Public School System, University of South Alabama's College of Education, Mobile Area Education Foundation and 100 Black Men of Mobile; Yr 1-2, partnerships, support of visits to DISL-Estuarium and Discovery Hall Program field-based programs by underserved / underrepresented students involved in summer and school-year programs

Alabama School of Mathematics and Science, Yr 2-3, partnership, support of lecture series for students at school by NGI and DISL researchers

Project WetKids, Yrs 2-3, partnership, support of visits to DISL-Estuarium by students involved in Mississippi's Project WetKids

Upward Bound, Yrs 2-3, partnership, support of visits to DISL-Estuarium by underserved / underrepresented students involved in Florida's and Alabama's Upward Bound program

7. Project Duration:

February 1, 2007 – January 31, 2010

8. Project Baselines:

Contributions to specific NOAA Goals/Objectives:

NOAA Goals 1 and 2. This project contributes to both goals of NOAA's Education Strategic Plan, Goal 1 Environmental Literacy and Goal 2 Workforce Development. Specifically, education and outreach efforts at DISL address Outcome 1.2 Educators understand and use environmental literacy principles; Outcome 1.3 Educators, students and/or the public collect and use ocean, coastal, Great Lakes, weather and climate data in inquiry and evidence-based activities; Outcome 1.4 Lifelong learners are provided with informal science education opportunities focused on ocean, coastal, Great Lakes, weather and climate education; Outcome 1.5 NOAA works cooperatively to maximize the impact of federal investment in ocean, coastal, Great Lakes, weather and climate education; and Outcome 2.1 A diverse and qualified pool of applicants, particularly from underrepresented groups, pursues student and professional opportunities for career development in NOAA mission-critical disciplines. Note that these goals are also identified as cross-cutting priorities in NOAA's Strategic Plan (2005).

Contributions to regional problems and priorities:

There are a number of regional organizations in the northern Gulf of Mexico area that have environmental education as a component of their mission or priorities. The Gulf of Mexico Alliance includes environmental education as one of their priority issues listing three actions relevant to this project. Specifically this NGI project contributes to ED-1 Action – Increase awareness and promote action among Gulf citizens by engaging in education and outreach activities; ED-2 Action – Expand public awareness efforts to connect the Gulf and its relevance to the lives of citizens; and ED-3 Action – Increase environmental literacy within the K through 20 audience by developing, implementing, expanding and enhancing specific environmental education programs. Additionally, Mississippi-Alabama Sea Grant identifies education and outreach as an important tool in support of their mission to enhance the sustainable use and conservation of ocean and coastal resources to benefit the economy and environment in Alabama and Mississippi. Florida's Sea Grant mission is to support integrated research, education, communication and extension to enhance the responsible use and conservation of coastal and marine resources to create a sustainable economy and environment. For Louisiana Sea Grant, education is recognized as a cross-cutting goal: An informed public that understands the value and vulnerability of coastal, ocean, and Great Lakes resources and demands informed science-based decisions about the conservation, use, and management of these resources and a well-trained workforce will make this a reality.

How the project has narrowed gaps in regional knowledge, data, model performance, geographic coverage, etc.:

This project is addressing gaps in Gulf of Mexico Ocean Literacy using a variety of approaches including various media and target audiences. NGI educators have interacted with a number of student groups (detailed below). Informational panels have been developed and displayed in the Estuarium, Dauphin Island Sea Lab's public aquarium. An educator has been posted in the Estuarium and is informing visiting educational groups and the general public about Gulf of Mexico topics and issues as well as NGI research. Other activities are delineated below.

9. Objectives/Milestones accomplished in this period:

Outreach to the public (primarily through the Estuarium)

During the period of this grant, visitorship to the Estuarium totaled 204,416.

Informational panels have been developed for the Estuarium on the NGI as an organization, as well as various NGI projects and researchers.

A weekly series of informal conversations between scientists and Estuarium visitors, *Boardwalk Talks*, has been developed and continues to this day. Topics include general ocean literacy as well as specific NGI related issues and projects.

A summer series of field trips for the public, *Summer Excursions*, has been developed and implemented offering ~8 dates throughout the summer where members of the public can visit specific marine habitats with a NGI Educator (Figure 5).

Figure 5. NGI Educator, Dr. Tina Miller-Way, working with a student group visiting the Dauphin Island Sea Lab

Two child-appropriate exhibits ("Can you keep it" and "Which Niche is which") have been developed and installed in the Estuarium

An interactive kiosk featuring stories about Gulf of Mexico watershed issues has been developed in collaboration with the National Mississippi River Museum and Aquarium and is currently installed in the Estuarium (Figure 6).

The curriculum used by students visiting the Estuarium has been updated to include new NGI-related content.

The NGI Estuarium Educator greets and gives a brief introduction for most groups visiting the Estuarium (when she is working).

NGI E&O Staff at DISL routinely participate in environmental themed outreach events, including Discovery Day (DISL's annual open house), Earth Day, ShrimpFest, Environmental Studies Center open house and many more.

Figure 6. NGI-funded interactive kiosk located in the Estuarium at the Dauphin Island Sea Lab

Education - K-12 students and educators, including underserved / underrepresented groups

Information on NGI scientific themes has been infused into Discovery Hall programs (academic year K-12 classes, middle school summer camps, summer high school course, teacher workshops).

NGI educators developed, implemented and routinely offer a unit on watersheds and water quality to through the BayMobile, DISL's traveling marine science classroom.

NGI educators have worked with several underserved populations in Mobile County (described under collaborations/partnerships) educating students about watershed concepts and issues and ocean literacy, including NGI research.

NGI has supported a scholarship for a high school student to attend DISL's residential summer marine science course.

By application and review, the Discovery Hall Programs have earned AMSTI Affiliate status, resulting in potentially wider distribution of the content in our teacher workshops.

A teacher has been recruited to participate in Dr. Kyeong Park's research cruise to the Gulf of Mexico continental shelf.

Personnel

As proposed, a full-time person with training in research and science education has been hired and is fully integrated into DISL education and outreach programs. This person has served as a conduit for information about current research to, and developing activities focused on some of these issues for, the education community at DISL and in the Gulf region. Time has been spent working collaboratively or in partnership with other environmental organizations in the northern Gulf region (these are detailed above). Time has also been spent writing proposals and implementing them when successful (B-WET, CELC, GOMA).

As proposed, a part-time (50%) person has been hired to conduct education activities in the Estuarium and is fully integrated into DISL education and outreach programs.

Two graduate students have been supported through this grant.

Other

In collaboration with several other Gulf of Mexico agencies, a social marketing survey addressing the public's understanding and opinions of nutrients and their role in the Gulf of Mexico ecosystem has been developed, conducted and published.

Figure 7. NGI Educator, Ms. Mendel Graeber speaking about watersheds and the northern Gulf of Mexico at a recent outreach event.

10. Significant research results, protocols developed, and research transitions

Not applicable for this project.

11. Outreach activities

Given the nature of this project, please see the milestones above for details on our outreach efforts.

12. Peer Reviewed Articles

None

13. Non-refereed articles and reports for this project

None

14. Conference presentations and poster presentations for this project

Presented Paper **What's in a watershed?** Ms. Mendel Graeber, North American Association for Environmental Education, November 2007, Virginia Beach, VA.

Presented Paper **Post-Katrina Impacts to Colonial Nesting Birds in Coastal Alabama**. Dr. John Dindo and Mr. Orin Robinson, Northern Gulf Institute 2008 Annual Conference, May 2008, Biloxi, MS.

Presented Paper **Biomagnification of mercury in the Mobile Bay Ecosystem**. Ms Lauren Showalter, Northern Gulf Institute 2009 Annual Conference, May 2009, Mobile, AL.

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

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

Presented Paper **NGI in the Dauphin Island Sea Lab's Estuarium**, Ms. Mendel Graeber, Northern Gulf Institute Annual Conference, May 2009, Mobile, AL.

Presented Paper **Education and Outreach at the Dauphin Island Sea Lab**, Ms. Mendel Graeber, Bays and Bayous, October 2008, Biloxi, MS.

Presented Poster **Marine Research Meets Education at the Dauphin Island Sea Lab**, Dr. John Dindo, Dr. Tina Miller-Way and Ms. Mendel Graeber, Northern Gulf Institute 2008 Annual Conference, May 2008, Biloxi, MS.

Presented Poster **Use of Stable Isotopes to determine biomagnifications of mercury in the Mobile Bay, Alabama Ecosystem**. Ms Lauren Showalter, Graduate Student Symposium, May 2009, Dauphin Island, AL.

15. Personnel from this project hired by NOAA during this reporting period:

None

16. NOAA Sponsor and NOAA office of primary technical contact for this project:

Julien Lartigue, NOAA Office of Oceanic and Atmospheric Research

PROJECT 06-DISL-02: RESTORING ESTUARINE LANDSCAPES IN ALABAMA COASTAL WATERS THROUGH THE CREATION OF OYSTER REEFS

1. Project Leads:

Name	*Title*	*Affiliation*	*Email*
Kenneth L. Heck, Jr	Project Lead	DISL and USA	kheck@disl.org

2. All Non-Student Personnel funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Kenneth L. Heck, Jr	PI	PhD	0	No
Dorothy Byron	Research Associate	MS	23	No
Quentin Sonnier	Research Associate	BS	50	No
Ariel Leon	Research Intern	BS	100	No

3. All Students funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Steven Scyphers	BS	PhD	0	No

4. Project Abstract:

Once thought valuable only as a fisheries commodity, oysters and the reefs they form are now recognized as essential habitat because of the ecological benefits they provide. As scientific and, more importantly, public recognition of the ecological benefits provided by oyster reefs has grown over the last decade, so too has the rationale and motivation for restorations of oyster reefs. The high cost of oyster reef restoration in estuaries is justified by the expectation of enhanced ecological benefits. Unfortunately, our ability to quantify and predict the magnitude of these benefits has failed to keep pace with the increasing demand for restoration. Here, we presented results from a study designed to examine the potential benefit of restoration of shallow subtidal oyster reefs on adjacent habitats, specifically shorelines with emergent marsh. We hypothesized that the creation of a complex "biogenic breakwater" would (1) facilitate the maintenance and expansion of other biogenic habitats; and (2) result in fisheries enhancement. We initially saw positive results due to the placement of the experimental breakwater complexes in reducing shoreline erosion and live vegetation retreat at Point aux Pins and Alabama Port; however, shoreline protection was not consistent and by the end of the study period there were no differences between control and reefs sites at Point aux Pins. The same trend was not seen at Alabama Port and may be due to the differences in wave climate between the two sites. We initially saw positive results in oyster recruitment and survival on both the seeded reefs at Point aux Pins and the non-seeded reefs at Alabama Port; however, these positive gains in oyster density did not continue through the duration of monitoring period. Finally, we saw positive results of elevated species richness and densities in large fish due to the presence of the breakwater complexes. We believe the initial positive results of many of our target variable were short lived due to the reduced capacity of the breakwater reefs after the active 2008 hurricane season which flattened and spread the reef complexes; thus, a sturdier design needs to be implemented for future oyster reef breakwaters to ensure little reef movement.

5. Key Scientific Questions/Technical Issues:

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

6. Collaborators/Partners:

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

Date collaborating established: Apr 2006

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

7. Project Duration:

April 1, 2006 – January 2010

8. Project Baselines:

Contributions to specific NOAA Goals/Objectives:

NOAA Goal 1: By restoring oyster reef habitat and monitoring parameters that involve the entire ecosystem, this project aims to protect and restore oyster reefs and shoreline, which are both habitats of special concern.

Contributions to regional problems and priorities:

This project addresses several regional priorities. One problem is the need to reverse the decline of near-shore essential fish habitats, such as salt marshes and submerged aquatic vegetation, and the consequent negative effects on the production of finfish and shellfish. Another is the need to restore lost oyster reef habitat in coastal Alabama, stemming from the catastrophic losses (nearly 89%) that began after Hurricane Ivan and have not yet been substantially reversed.

How the project has narrowed gaps in regional knowledge, data, model performance, geographic coverage, etc.

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.

9. Objectives/Milestones accomplished in this period

- Construction of the reefs was completed in May 2007 (Point aux Pins reefs) and November 2007 (Alabama Port reefs).

- Sampling of proposed physical and chemical measurements (Physical surveys, oyster density surveys, water clarity, benthic microalgae, benthic macroalgae, marsh vegetation, benthic macrofauna, juvenile fish and mobile invertebrates and large fish) following sampling schedule presented in the proposal was concluded at both sites (Point aux Pins, final sampling in August 2009; Alabama Port, final sampling in January 2010) and all samples collected have been processed.
- Publication detailing the fisheries enhancement of the oyster reef breakwaters has been drafted.

10. Significant research results, protocols developed, and research transitions

- We initially saw positive results due to the placement of the experimental breakwater complexes in reducing shoreline erosion and live vegetation retreat at Point aux Pins and Alabama Port; however, shoreline protection was not consistent and by the end of the study period there were no differences between control and reefs sites at Point aux Pins. The same trend was not seen at Alabama Port and may be due to the differences in wave climate between the two sites. Vegetation retreat; however, was reduced consistently throughout the study period, but again differences between reef and control sites were

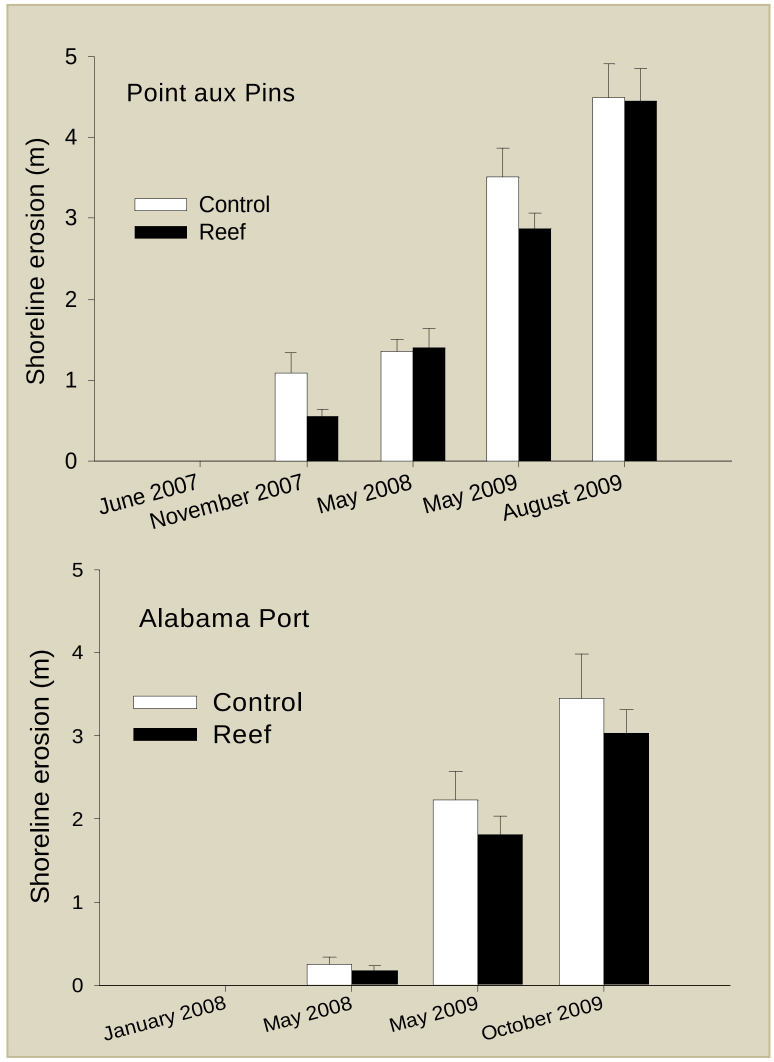


Figure 8. Average shoreline erosion for Point aux Pins treatments (control and reef) across time and Alabama Port treatments (control and reef) across time. Distance values are cumulative.

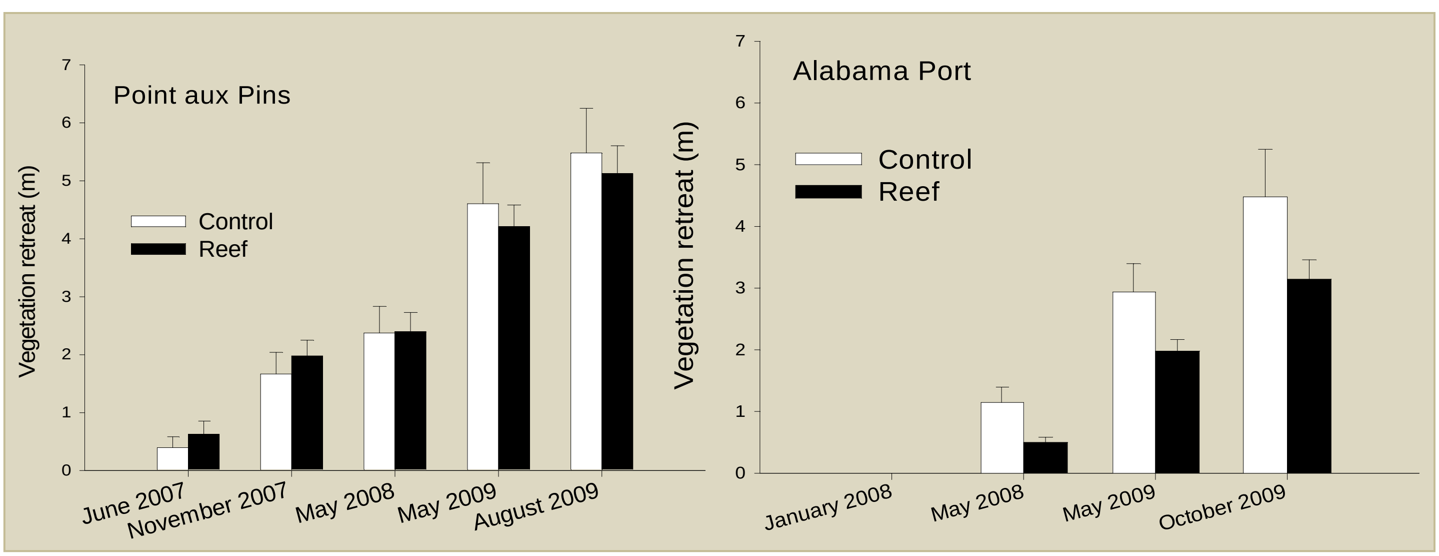


Figure 9. Retreat of live vegetation edge (m) during each survey period at Point aux Pins and Alabama Port. Distance values are cumulative.

greater at Alabama Port and may also be a function of wave climate and habitat type. Additionally, shoreline protection by the breakwater complexes was most likely reduced in capacity after the active 2008 hurricane season which flattened and spread the reef complexes (Figure 4 and Figure 5).

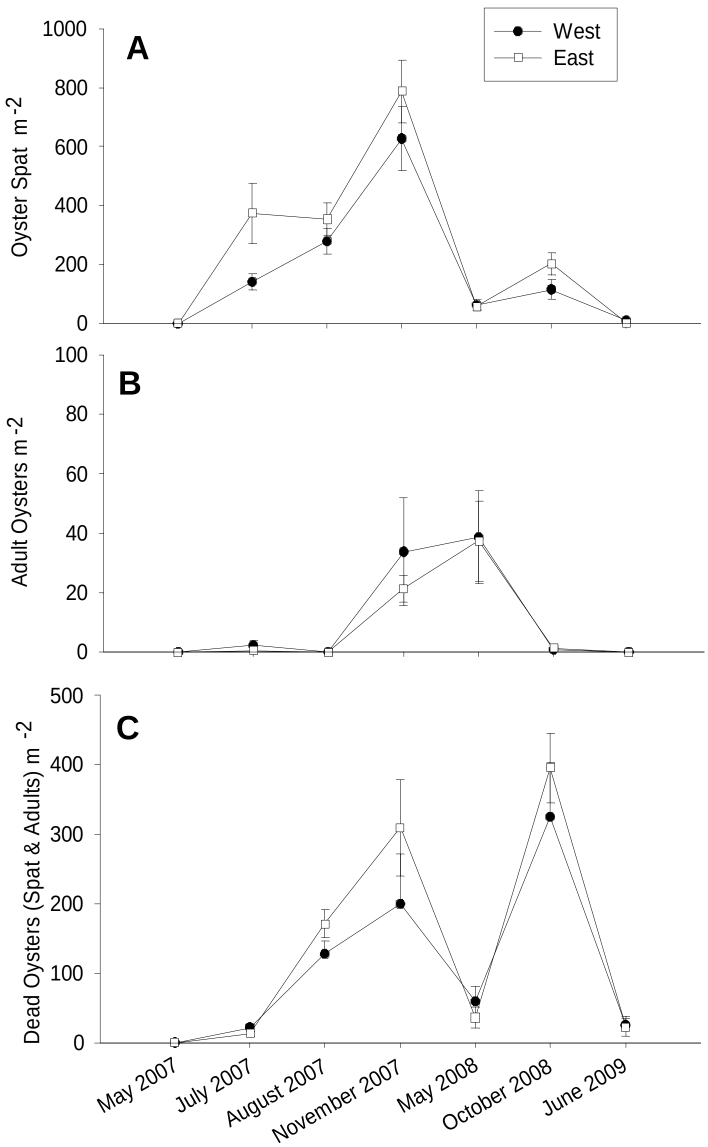


Figure 10. Density of A) spat and juvenile oysters B) adult oysters and C) dead oysters across time at Point aux Pins breakwater complexes

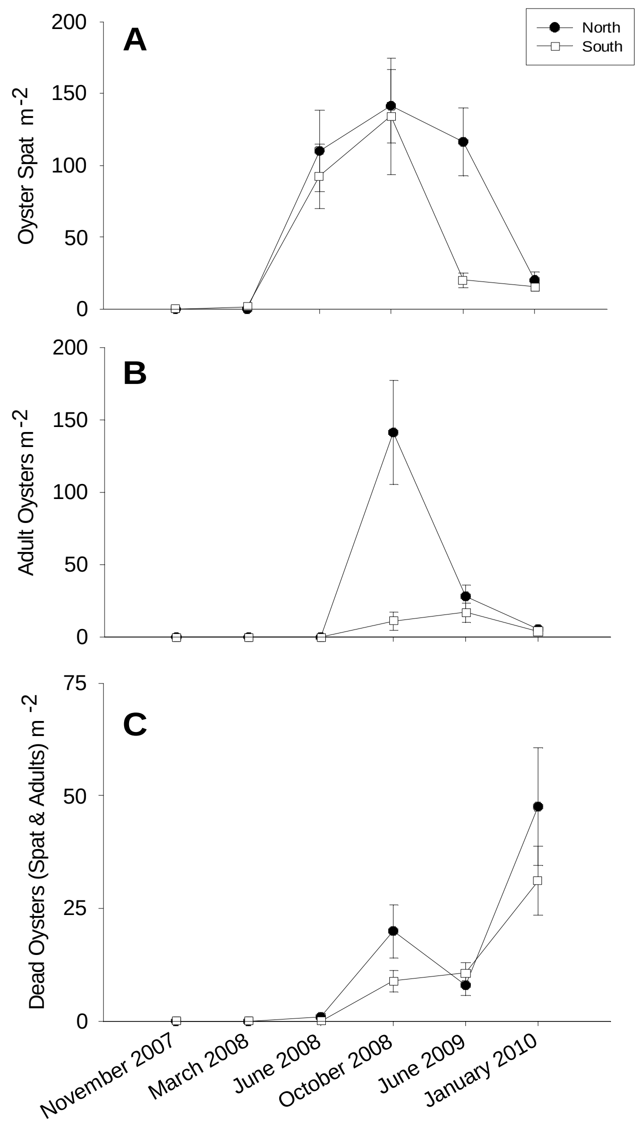


Figure 11. Density of A) spat and juvenile oysters B) adult oysters and C) dead oysters across time at Alabama Port breakwater complexes

- We initially saw positive results in oyster recruitment and survival on both the seeded reefs at Point aux Pins and the non-seeded reefs at Alabama Port; however, these positive gains in oyster density did not continue through the duration of monitoring period. The decline in spat recruitment over time may be due to a lower percentage of reef sampled as there was some reef spreading, especially during the active 2008 hurricane season and the sampling protocol was not updated until the final samples were taken. Moreover, during these reef spreading events, the top layer of oyster shell with newly settled spat and juvenile oysters may have been overturned, leaving clean unsettled shell on the reef crest, thereby resulting in underestimates of oyster density from surveys taken at the center of the reef (Figure 10 and Figure 11).

- We saw positive results of elevated species richness and densities in large fish due to the presence of the breakwater complexes. From our seines, we found blue crabs, caridean shrimp, and juvenile silver perch were more abundant near oyster reefs than mudflat controls providing further evidence of the refuge value of such structured habitats. The increase in prey species such as the blue crabs and caridean shrimp, which are commonly found in the diets of several of the larger fishes, may have attracted the larger fish community to the breakwater complexes resulting in the fisheries enhancement we saw at the reef sites (Figure 12).

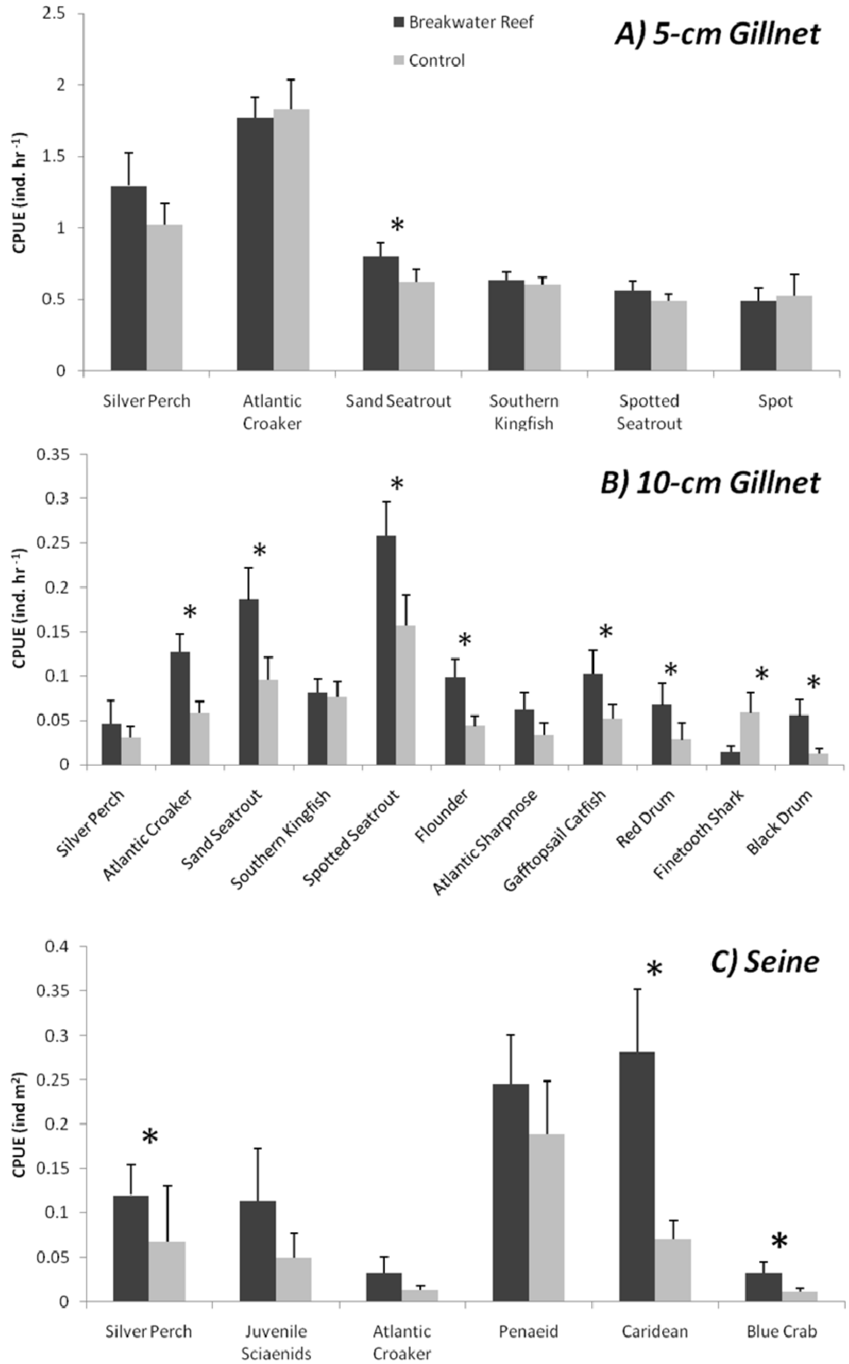


Figure 12. Mean ± SE CPUE of dominant demersal and decapod species or grouped taxa between treatments. Significant differences at P≤0.05 from paired t-tests comparing paired breakwater reef and control treatments.

11. Outreach activities

- Dr. Heck and Dr. Powers gave an interview with Local Channel Five News (WKRG) (Dec 2007).
- Steven Scyphers gave an oral presentation “Applying Technology to Marine Research: Oyster Reef Habitat Restoration and Shoreline Stabilization in Coastal Alabama” during the Marine Applications of Science and Technology Workshop for High School Science Teachers. Dauphin Island Sea Lab. Dauphin Island, AL. June 2, 2008.
- Dauphin Island Sea Lab's “Discovery Day”, April 19, 2008 – display demonstrating the importance of oyster habitat and interactive display demonstrating how breakwaters made of oyster shell function.
- Article published in Mobile Press Register, May 11, 2008. 'Living shoreline' aims to stop harmful bathtub effect of Mobile Bay bulkheads. By Ben Raines
- Dr. Heck gave an oral presentation “Oyster Reef and Landscape Restoration” for the Center for Ocean Sciences Education Excellence: Central Gulf of Mexico (COSEE:CGOM) July 2009

- Dauphin Island Sea Lab's "Discovery Day", April 17, 2010 – display demonstrating the importance of oyster habitat and interactive display demonstrating how breakwaters made of oyster shell function

12. Peer Reviewed Articles

None

13. Non-refereed articles and reports for this project

None

14. Conference presentations and poster presentations for this project

- Scyphers, S., K. Heck, S. Powers. Oyster Reef and Estuarine Landscape Restoration. November 5-7, 2007. Oral Presentation. Mobile Bay Collaboration Network Workshop.
- Heck, K., S. Powers. Oyster Reef and Estuarine Landscape Restoration. May, 2007. Oral Presentation. NGI Annual Conference.
- Scyphers S., S. P. Powers, K.L. Heck Jr. and C. Steeves. 2007. Restoring Estuarine Landscapes in Coastal Alabama Through Creation of Oyster Reefs. November 4, 2007. Oral Presentation. NGI Mobile Bay Collaborative Meeting.
- Scyphers, S.B, Powers, S.P., Heck, K.L., Steeves, C.R. Shoreline Stabilization and Fisheries Benefits of Oyster Reef Restoration in Coastal Alabama. April 6-10, 2008 Oral Presentation. 100th Annual National Shellfisheries Association Meeting.
- C.R. Steeves, K. Heck, S. Powers and S. Scyphers. The Effects of Breakwater Oyster Reefs on Coastal Ecosystems in the Northern Gulf of Mexico. April 10-12, 2008. Poster Presentation. Benthic Ecology Meeting.
- K. Heck, S. Powers, C.R. Steeves, and S. Scyphers. The Effects of Breakwater Oyster Reefs on Coastal Ecosystems in the Northern Gulf of Mexico. May 13-14, 2008. Poster Presentation. Northern Gulf Institute Annual Conference.
- Scyphers, S., K. Heck, S. Powers. Oyster Reef and Estuarine Landscape Restoration. November 5-7, 2007. Oral Presentation. Mobile Bay Collaboration Network Workshop.
- K. Heck, S. Powers. Oyster Reef and Estuarine Landscape Restoration. May, 2007. Oral Presentation. NGI Meeting.
- 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. Alabama Oyster Reef and Fisheries Habitat Enhancement Program. November 19-22, 2008. Poster Presentation. International Conference on Shellfish Restoration, SC SeaGrant, Charleston, SC.
- 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.
- Scyphers, S.B., Powers, S.P., Heck, K.L., Lott, M.A., Quantifying the benefits of oyster restoration: A tool for promoting living shorelines? April 3-5, 2009. Oral Presentation, Gulf of Mexico Graduate Student Symposium, Dauphin Island, AL.
- Scyphers, S.B., Powers, S.P., Heck, K.L., Lott, M.A., Quantifying the benefits of oyster restoration: A tool for promoting living shorelines? February 23-25, 2009. Oral Presentation. Alabama Fisheries Association Conference, Auburn, AL.
- Scyphers, S.B., Powers, S.P., Heck, K.L., Lott, M.A., Restored oyster reefs as natural breakwaters for estuarine shorelines: Quantifying the fisheries benefits of living shorelines. April 13-16, 2009. Oral Presentation. Gulf and South Atlantic States Shellfish Conference, Ocean Springs, MS.

15. Personnel from this project hired by NOAA during this reporting period:

None

16. NOAA Sponsor and NOAA office of primary technical contact for this project:

Julien Lartigue, NOAA Office of Oceanic and Atmospheric Research

PROJECT 06-LSU-01: DELTA ECOSYSTEM FORECASTING SYSTEM

1. Project Leads:

Name	*Title*	*Affiliation*	*Email*
Dubravko Justic	Lead	Louisiana State University	djusti1@lsu.edu
Kenneth Rose	Co-PI	Louisiana State University	karose@lsu.edu
Chunyan Li	Co-PI	Louisiana State University	cli@lsu.edu
Robert Twilley	Co-PI	Louisiana State University	rtwilley@lsu.edu

2. All Non-Student Personnel funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Dubravko Justic	PI	PhD	8.3%	No
Kenneth Rose	Co-PI	PhD	8.3%	No
Chunyan Li	Co-PI	PhD	8.3%	No
Robert Twilley	Co-PI	PhD	0%	No
Asif Hoda	Post doc	PhD	100%	No
Paul Venturelli	Post doc	PhD	16.7%	No

3. All Students funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Anindita Das	MS	PhD	50%	No
Kim DeMutsert	MS	PhD	50%	No

4. 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 km^2) 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.

5. Key Scientific Questions/Technical Issues:

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.

6. Collaborators/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).

7. Project Duration:

Start date: 2/1/2007
Estimated end date: 9/30/2010 (No Cost Extension)

8. Project Baselines:

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.

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.

How the project has narrowed gaps in regional knowledge, data, model performance, geographic coverage, etc.:

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).

9. Objectives/Milestones accomplished in this period

- We have developed and calibrated two simulation models of Barataria Bay estuary, a simple 6-box mass-balance model and a high resolution two-dimensional (2-D) coupled hydrology-hydrodynamic-water quality model.

- We have implemented a three-dimensional, unstructured-grid, Finite Volume Coastal Ocean Model (FVCOM) to the Louisiana-Texas shelf. A number of FVCOM simulations have been carried out that pertain to the dynamics of river plumes, river floods, storm surge events and dynamics of Gulf's hypoxia.
- FVCOM model has been applied to Lake Pontchartrain. Field and modeling studies have been conducted to assess the impacts of winter storms, hurricane storm surges, and lake-wide responses to the 2008 fresh water diversion of the Bonnet Carre Spillway.
- A high-resolution FVCOM grid (10 m) has been developed for the study of DELTA hydrodynamics. Several months of simulations have been completed.
- Several FVCOM applications for storm surge simulations have been developed by a graduate student J. Rego (see publication and conference presentation list). In addition, a new FVCOM model for storm surge simulations is being developed and tested. We have completed a 45-day simulation of tidal forcing and a 15-day simulation of storm surges caused by Hurricane Gustav.
- 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 preformed some preliminary testing of the model by using FVCOM output as input to the marsh IBM.
- Kim DeMutsert, who was partially supported by this project, examined effects of the Caernarvon freshwater diversion on nekton in Breton Sound as a part of her PhD dissertation.

10. Significant research results, protocols developed, and research transitions:

- Box and 2-D model results indicated that Barataria Bay estuary imports nitrogen and exports carbon to the coastal ocean. Compared to the lower Mississippi River, Barataria estuary appears to be a very small source of total organic carbon for the northern Gulf of Mexico and is unlikely to have a significant influence on the development of the Gulf's hypoxia. Tracer simulation experiments have shown that residence times differ markedly at different locations within the same water body due to differences in small scale hydrodynamics. Model simulations also pointed out the differences in spatial patterns in phytoplankton response to distributed freshwater and nutrient inflows, reflecting the near-field control of nutrients and far-field control of residence times on phytoplankton standing stock.
- FVCOM simulations were carried out over a six-month period, from April to September 2002, and the model performance was evaluated against several independent series of observations that included tidal gauge data, Acoustic Doppler Current Profiler (ADCP) data, shipboard measurements of temperature and salinity, vertical salinity and sigma-t profiles, and satellite imagery. The seasonal cycle of stratification also was well represented by the model. Model simulations support the conclusion that local wind forcing and buoyancy flux resulting from riverine freshwater discharges were the dominant mechanisms affecting the circulation and stratification over the inner Louisiana-Texas shelf.
- Using a Before-After-Control-Impact study, DeMutsert demonstrated that nekton species biomass distributions (SBD) changed significantly after the opening of the Caernarvon freshwater diversion 1991. The biomass of selected economically or ecologically important species showed an increase relative to the control (*Micropterus salmoides, Micropogonias undulatus, Brevoortia patronus, Farfantepenaeus aztecus* and *Litopenaeus setiferus)*, and one was not affected (*Cynoscion nebulosus*). In addition, nekton species richness, abundance and the proportion of smaller individuals increased, indicating increased nursery function.

11. Outreach activities:

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.

12. Peer Reviewed Articles

Rego, J., and C. Li. 2010. Storm surge propagation in Galveston Bay during Hurricane Ike, Journal of Marine Systems (Accepted).

Feng, Z., and C. Li. 2010. Cold-front-induced Flushing of the Louisiana Bays, Journal of Marine Systems (Accepted).

Li, C., H. Roberts, G. W. Stone, E. Weeks, Y. Luo. 2010. Wind Surge and Saltwater Intrusion in Atchafalaya Bay during Onshore Winds Prior to Cold Front Passage, Hydrobiologia (Accepted).

Rego, J. L., and C. Li. 2010. Nonlinear Terms in Storm Surge Predictions: Effect of Tide and Shelf Geometry with Case Study from Hurricane Rita, J. Geophys. Res., doi: 10.1029 / 2009JC005285 (In press).

Das, A., Justic, D., Swenson, E. 2010. Modeling estuarine-shelf exchanges in a deltaic estuary: Implications for coastal carbon budgets and hypoxia. Ecological Modelling 221: 978-985.

Li, C., E. Weeks, B. W. Blanchard. 2010, Storm surge induced flux through multiple tidal passes of Lake Pontchartrain estuary during Hurricanes Gustav and Ike, Estuarine, Coastal and Shelf Science 87 (2010) 517–525.

Li, C., E. Swenson, E. Weeks, J. White. 2009. Asymmetric tidal straining across an inlet: lateral inversion and variability over a tidal cycle, Estuarine, Coastal and Shelf Science, 85: 651-660.

Li, C., E. Weeks, J. Rego. 2009. In Situ Measurements of Saltwater Flux through Tidal Passes of Lake Pontchartrain Estuary by Hurricanes Gustav and Ike in September 2008, Geophysical Research Letters, VOL. 36, L19609, doi:10.1029/2009GL039802.

Justic, D., Wang, L. 2009. Application of Unstructured-Grid Finite Volume Coastal Ocean Model (FVCOM) to the Gulf of Mexico Hypoxic Zone. Proceedings of the 2009 MTS/IEEE conference, Ocean Technology for Our Future: Global and Local Challenges, 26-29 October 2009, Biloxi, Mississippi, MTS, ISBN No. 978-0-933957-38-1.

Rego, J., C. Li. 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 29: 1464-1476.

13. Non-refereed articles and reports for this project

None

14. Conference presentations and poster presentations for this project

Justic, D., Wang, L., Hoda, A., Das, A. 2010. From box models to mega models: Can biology and people keep up with computers? ASLO/NABS 2010 Joint Summer Meeting, June 6-11, 2010, Santa Fe, New Mexico.

Hou, A., C. Li. 2010. Water Quality in Lake Pontchartrain Ecosystem in the Aftermath of Hurricane Katrina: Great Resilience and Mechanisms. “Returning to Katrina: Bringing Hurricane Katrina Research back to the Community” Conference, Long Beach, MS. June 4-5, 2010.

Babin, B., Justic, D. 2010. Development of a relational database in support of the DELTA ecosystem forecasting system. 2010 Northern Gulf Institute Annual Conference, May 18-20, 2010, Mobile, Alabama.

Li., C., Justic, D., Rose, K., Rego, J., Twilley, R., Chen, C., Huang, H., Lin, H. 2010. Storm surges: Research efforts at LSU. 2010 Northern Gulf Institute Annual Conference, May 18-20, 2010, Mobile, Alabama.

Rego, J., C. Li. 2010. Mitigation of hurricane storm surge impacts: Modeling scenarios over wide continental shelves. EGU General Assembly 2010, Vienna, Austria, May 2-7, 2010.

Justic, D. 2009. High resolution water quality models for the northern Gulf of Mexico: Can biology and people keep up with computers? Texas A&M University Seminar, College Station, November 30, 2009.

Das, A., Justic, D., Swenson, E. M., Hoda, A., Inoue, M., Park, D. 2009. Water, Carbon and Nitrogen Fluxes in a Deltaic Estuary: The Outwelling Hypothesis Revisited. Annual Graduate Student Seminar Program, School of the Coast and Environment, Louisiana State University, November 20, 2009, Baton Rouge, Louisiana, 70803.

Justic, D., Wang, L. 2009. Application of unstructured-grid, finite volume coastal ocean model (FVCOM) to the Gulf of Mexico hypoxic zone. The 20th Biennial Conference of the Coastal and Estuarine Research Federation, November 1-5, 2009, Portland, Oregon.

Li, C., J. White, E. Weeks. 2009. Tidal flushing of a shallow bay into Louisiana Shelf: Intra-tidal variations and net transport of water, nutrients, and suspended sediments. The 20th Biennial Conference of the Coastal and Estuarine Research Federation, November 1-5, 2009, Portland, Oregon.

Das, A., Justic, D., Swenson, E. M., Hoda, A., Inoue, M., Park, D. 2009. Water, Carbon and Nitrogen Fluxes in a Deltaic Estuary: The Outwelling Hypothesis Revisited. The 20th Biennial Conference of the Coastal and Estuarine Research Federation, November 1-5, 2009, Portland, Oregon.

Justic, D., Rose, K., Li, C., Wang, L., Hoda, A., A. Das. 2009. Development of 2-D and 3-D water quality models for coastal Gulf of Mexico. 2009 NGI-Shell Fall Workshop, October 2, 2009, Baton Rouge, Louisiana.

Li, C., C. Chen, N. Rabalais, H. Lin, G. Turner, D. Braud, R. Twilley, E. Weeks. 2009. Application of Finite Volume Coastal Ocean Model to the Coast of Southeast Louisiana, National Conference on Ecosystem Restoration, Los Angeles, July 20-24, 2009.

15. Personnel from this project hired by NOAA during this reporting period:

None

16. NOAA Sponsor and NOAA office of primary technical contact for this project:

Julien Lartigue, NOAA Office of Oceanic and Atmospheric Research

PROJECT 06-LSU-02: PUBLIC HEALTH AND STRESSORS

1. Project Leads:

Name	*Title*	*Affiliation*	*Email*
Sibel Bargu Ates	Project Lead	Louisiana State University	sbargu@lsu.edu
Brian Fry	Co-PI	Louisiana State University	bfry@lsu.edu
Eugene Turner	Co-PI	Louisiana State University	euturne@lsu.edu
Aixin Hou	Co-PI	Louisiana State University	ahou@lsu.edu

2. All Non-Student Personnel funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Charlie Milan	Research Associate	MS	12%	No
Erick Swenson	Research Associate	MS	10%	No
Sara Green	Postdoctoral Researcher	PhD	25%	No
Kari Galvan	Postdoctoral Researcher	PhD	13%	No
Hee-Sung Bae	Research Associate	MS	20%	No

3. All Students funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Jessica Czubakowski	BS	MS	100%	No
Brian Matherne	MS	MS	50%	No
Nabanita Bhattacharyya	BS	MS	50%	No

4. 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.

5. Key Scientific Questions/Technical Issues:

The overall hypothesis of the proposed work is: *changing hydrologic regimes and nutrient loadings will impact ecosystem restoration and public health in coastal waters*.

The specific objectives and related approaches of this project are:

1. To quantify temporal and spatial dynamics of community biomass in the two Louisiana estuaries;

2. To determine plankton community metrics, using fingerprint of microbial metabolites, nutrient bioassays (algae), relative bacteria densities, and to examine proxies of water quality preserved in sediment records;

3. To routinely sample estuarine waters to quantify occurrence and abundance of harmful algal species, and also begin to quantify HAB toxicity using ELISA and HPLC;

4. To develop qPCR protocols to detect and quantify potentially pathogenic *Vibrio* species of interest in coastal waters and study the temporal and spatial dynamics of *Vibrio vulnificus* and *Vibrio parahaemolyticus* using both culturing and molecular methods;

5. To determine the impacts of physiochemical parameters (temperature, salinity, and nutrients in particular) on the development of microbial populations.

6. Collaborators/Partners:

This Project is coordinated with the DELTA observation system proposed with funding from a Shell grant to LSU.

7. Project Duration:

July 1, 2007 – October 31, 2010

8. Project Baselines:

Contributions to specific NOAA Goals/Objectives:

NOAA Goals 1, 2, and 3. The Mississippi River Delta is one of the most impacted coastal ecosystems in the world including four of the most significant national issues relative to the NOAA mission: 1) climate change and sea level impacts on coastal resources; 2) hazards including hurricane disturbance to cultural, economic and natural resources of coastal regions; 3) habitat loss and ecosystem management including the loss of nearly one-third of the deltaic wetland landscape (4,500 km2) in the last one hundred years; and 4) water quality including the periodic occurrence of one of the largest hypoxic zones among coastal ocean regions.

Contributions to regional problems and priorities:

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.

How the project has narrowed gaps in regional knowledge, data, model performance, geographic coverage, etc.

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. The Deepwater Horizon oil spill is a further stressor on this ecosystem, although unexpected. Our measurements will be particularly useful to assess oil impacts throughout the next year, assuming that funding is available to continue these measurements.

9. Objectives/Milestones accomplished in this period

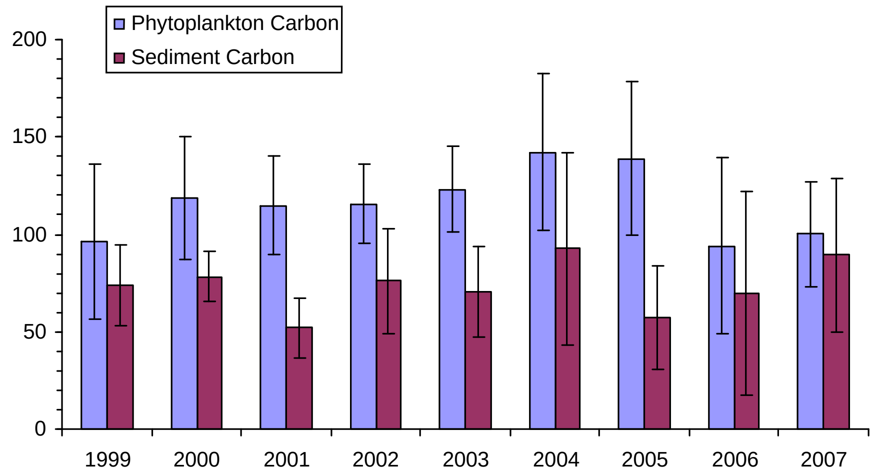


Figure 13. Interannual Summary – averages for the entire transect, 1999-2007 - Errors are 95% CL

1. 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 9). 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 ^{13}C and depleted ^{15}N, 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.

New data were also analyzed to help budget what was happening to Mississippi River nitrate that was entering upper Breton Sound at Caernarvon. The data suggest that phytoplankton uptake is likely the major sink for nitrate at Caernarvon. The strongest biological uptake signals occurred in July at moderate residence times (and presumably moderate river flows) (Figure 13). Strong DO spikes and DIC sags at station 4 (eastern Lake Leary) (data is not shown) demonstrated that a large phytoplankton bloom developed, and using Redfield stoichiometry, the estimate for phytoplankton uptake is about 60% of the total nitrate lost. This is probably a minimum estimate because hydrology is dispersing some of the bloom signals. Macrophyte uptake probably is also very important in Lake Leary, accounting for the strong "estuarine filter" effect and about 100% nitrate removal unless diversion flows are very strong (as they were in April 2008)

2. Turner Lab: Sixteen 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 14). There are few indications that the Davis Pond diversion water has affected the microbial community in Lake Salvador. There are no unusual changes in the microbial fingerprint in April and May, 2010, two months after the Deepwater Horizon oil spill. However, oil has started to move into the lower estuary and changes are expected in the next several months.

3. Bargu Lab: The role of nutrient loaded freshwater pulses on phytoplankton succession and phycotoxin production in Breton Sound Estuary, Louisiana is studied. In the Breton Sound estuary, biological responses to long-term environmental changes are driven by nutrient availability and seasonal changes in salinity and water temperatures. During short-term changes in river input rates, P concentrations, as well as the distance from the diversion structure were important. The phytoplankton community composition shifted from cyanobacteria for the majority of the year, to chlorophytes in response to seasonal changes in environmental conditions during the cool season (Figure 15). Overall, the phytoplankton community of Breton Sound estuary appears to be moderated by temperature during the cool season and nutrient availability during the warm season. MCs production followed cyanobacteria abundances spatially and temporally as was predicted (Figure 16). Phycotoxins, including MCs, have now been detected in water samples in Breton Sound estuary, as well as primary and secondary consumers (chironomids, clams, blue crab and catfish), in two estuaries and coastal Louisiana, illustrating the need for continued monitoring and research to discover the underlying factors that control toxin production. Finding phycotoxins in the estuary illustrates the potential for harmful effects on consumers and the entire food web, as well as the need to understand what underlying conditions increase the potential for toxin production. Including more environmental variables and utilizing more frequent and dense spatial sampling could also help determine additional influences on the phytoplankton community and potentially aid in model validation.

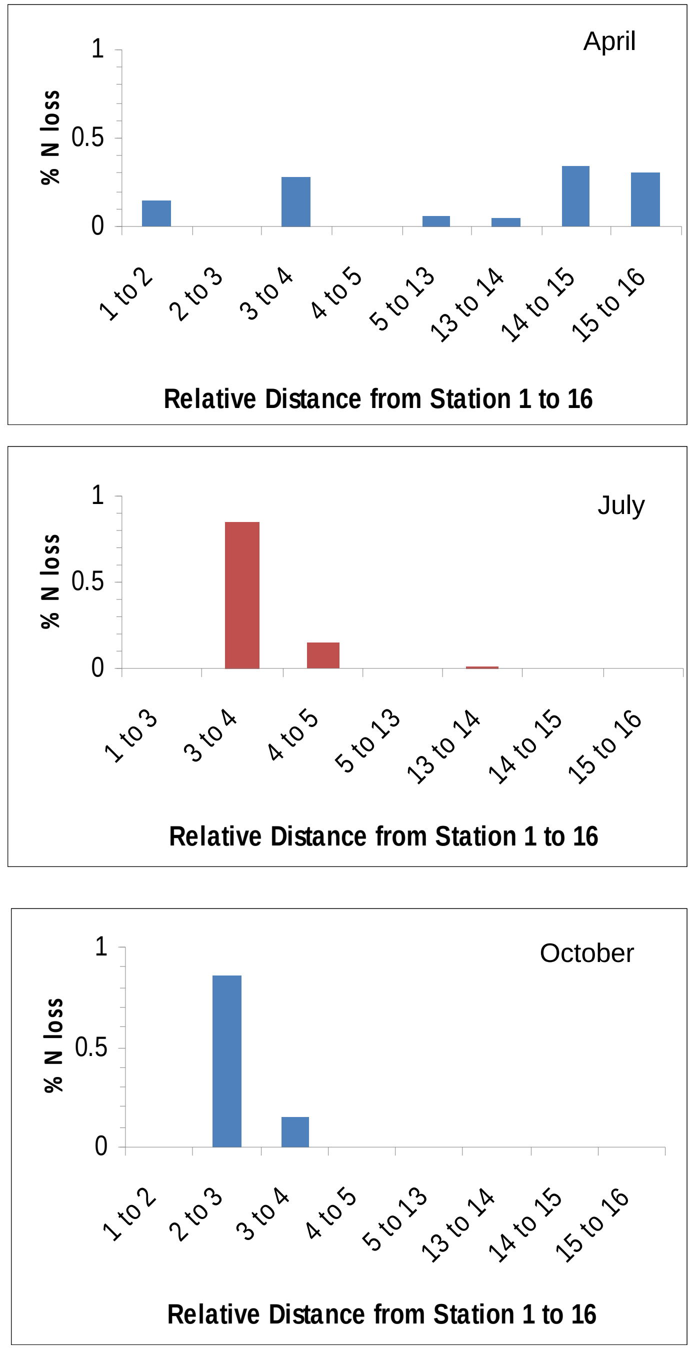


Figure 14. Caernarvon 2008 corrected t12,16 and 19 Corrected + mainline graph; 18o nitrate model

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.

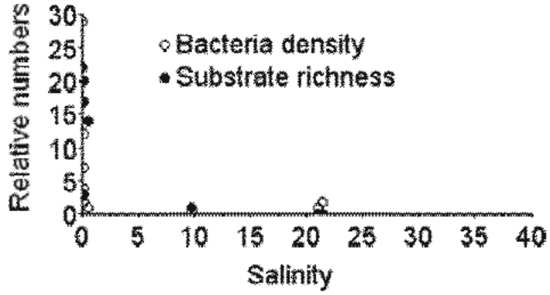


Figure 15. Barataria transect showing the changes in bacteria density and microbial metabolic 'footprint' based on salinity changes.

Finally, we investigated the impacts of Hurricanes 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.

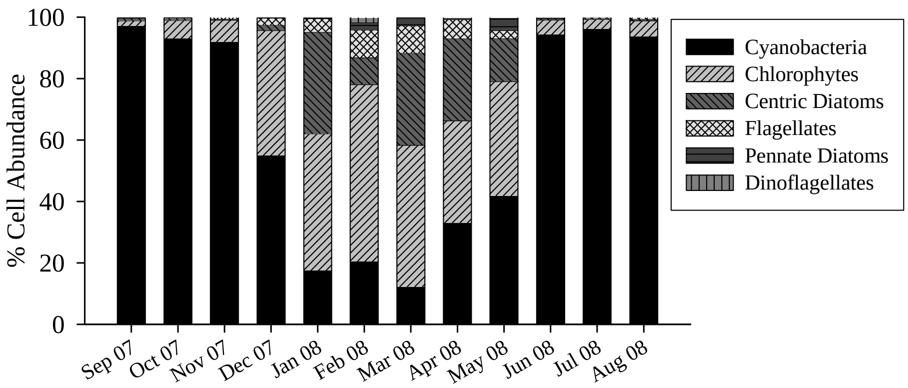


Figure 16. Percent abundance of individual phytoplankton groups for each month from September 2007 to August 2008.

4. Hou Lab: Water samples were collected along salinity gradient transects in these two water bodies, at a monthly frequency, from September 2007 through June 2010, and from March 2008 through June 2010, sediment and live oyster samples were collected exclusively from the Breton Sound. Populations of total culturable *V. vulnificus* and *V. 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 17).

Both field data and laboratory testing shows salinity as one of the major impacting factors in *Vibrio* proliferation. For example, site 2 of Barataria with an annually average salinity of 18.7 g/L had an annually average putative *Vibrio* population of 277 CFU/100 mL in contrast to an average *Vibrio* population of 1 CFU/100 mL at site 33 with an average salinity of 0.15 g/L. It was also observed that the freshwater pulse events in Breton Sound lowered the *Vibrio* levels.

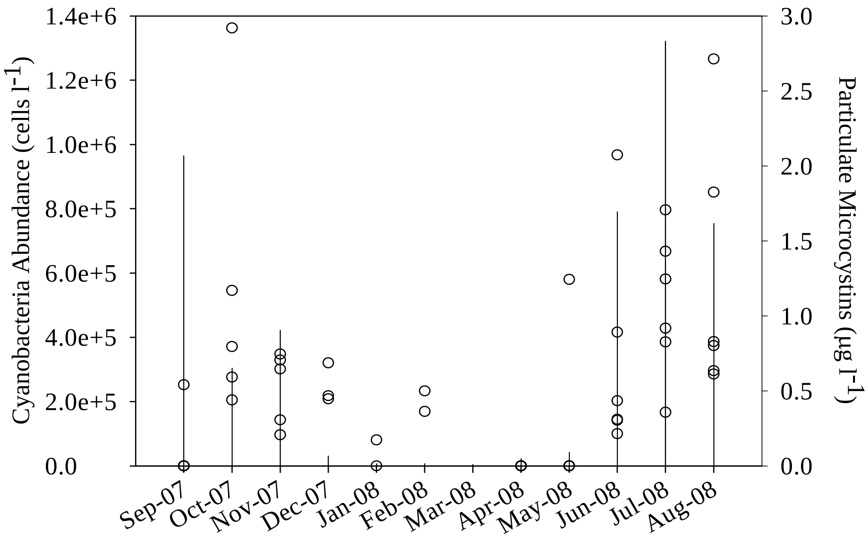
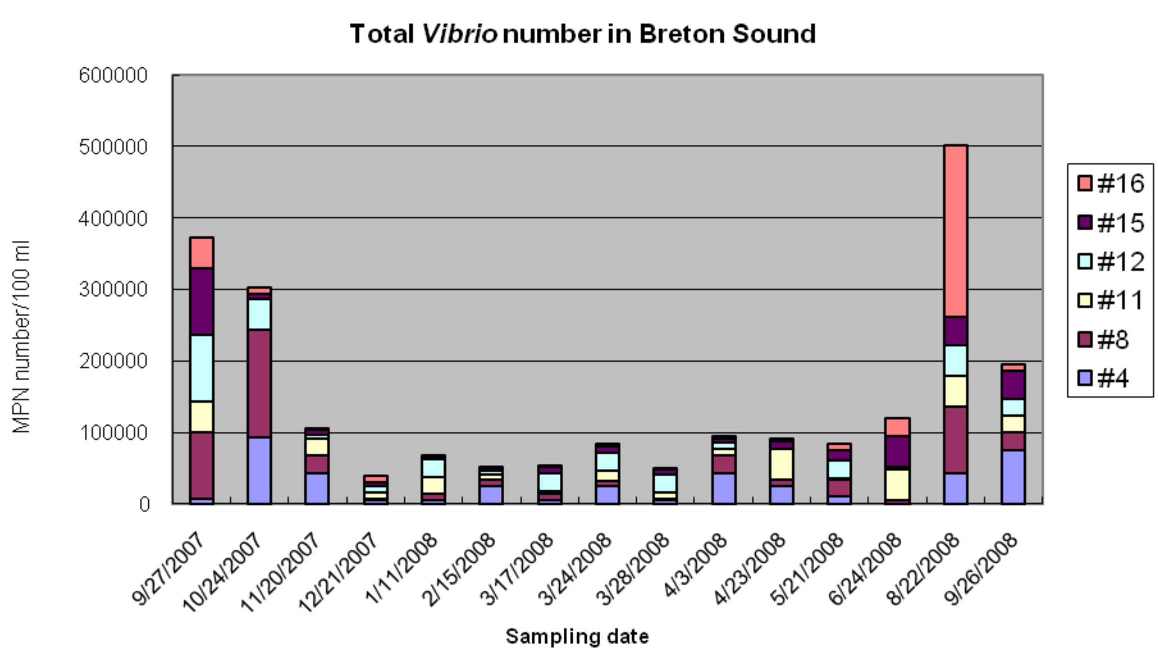


Figure 17. Average cyanobacteria cell abundances (vertical bars) from September 2007 to August 2008 with particulate microcystin concentrations (open circles) measured for each month in Breton Sound estuary during the study period.

Multiplex PCR protocols have been successfully established to detect total and pathogenic *V. vulnificus* and *V. parahaemolyticus* (Figure 18)

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.



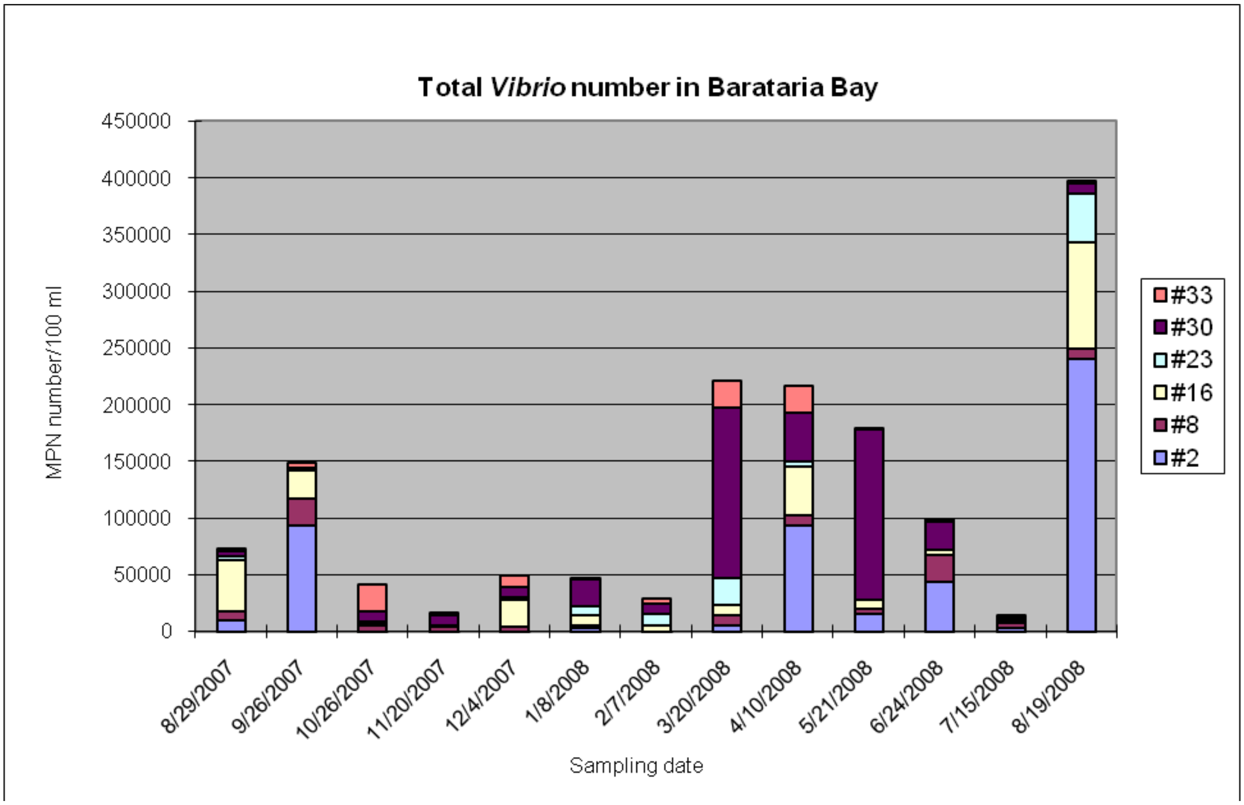


Figure 18. Complete year of *Vibrio* sampling from both Breton Sound and Barataria Bay

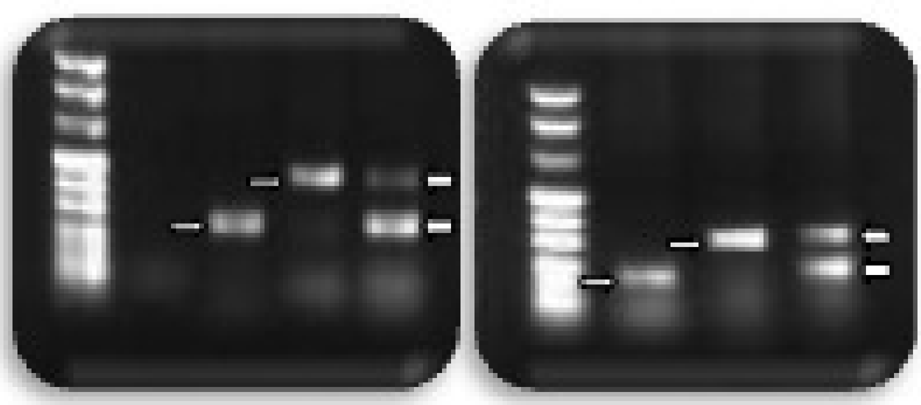


Figure 19. Left: Multiplex PCR detection of total and pathogenic genes of *V. vulnificus*. First column is negative strain, second column shows positive confirmation of total V. *vulnificus* vvhA gene, third column shows positive confirmation of viuB, and the fourth column shows confirmation of both vvhA and viuB genes. Right: Multiplex PCR detection of total and pathogenic genes of *V. parahaemolyticus*. First column shows confirmation of pathogenic tdh gene, second column shows confirmation of total *V. parahaemolyticus* tlh gene, and the third column shows the confirmation of both the tdh and tlh genes.

10. Significant research results, protocols developed, and research transitions

None

11. Outreach activities

None

12. Peer Reviewed Articles

Garcia, A.C., S. Bargu, P. Dash, N. Rabalais, M. Sutor, W. Morrison, N. Walker (2010) Evaluating the potential risk of microcystins to blue crab (*Callinectes sapidus*) fisheries and human health in a eutrophic estuary. *Harmful Algae*, 9:134-143

13. Non-refereed articles and reports for this project

None

14. Conference presentations and poster presentations for this project

J. Czubakowski and S. Bargu. 2010. Estuarine phytoplankton response to annual and manipulated river inputs. 2010 Northern Gulf Institute Annual Meeting, Mobile, AL (Oral).

Matherne, B.W. and A.X. Hou. 2010. Impacts of Salinity on Spatial Distribution of *Vibrio vulnficus* and *Vibrio parahaemolyticus* in Coastal Louisiana. Society of Environmental Toxicology and chemistry. May 2010, Seville, Spain (Poster).

Brian William Matherne, Martin Maxwell, Nabanita Bhattacharyya, and Aixin Hou. 2010. Populations of *Vibrio vulnificus* and *Vibrio parahaemolyticus* in Breton Sound and Barataria Bay. NGI conference, Alabama, MS (Oral).

J. Czubakowski, S. Bargu and R. R. Twilley. 2009. Potentially toxic estuarine phytoplankton communities directly influenced by river input controlled by a diversion structure. Coastal and Estuarine Research Federation Biannual Conference, Portland, OR (Oral).

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. 2009 Northern Gulf Institute Annual Meeting, Mobile, AL (Oral).

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).

S. Bargu, B. Fry, A. Hou, R.E. Turner. 2008. Public Health, Stressors and Water Quality in Coastal Louisiana. 2008 NGI conference, Biloxi, MS. (Poster).

J. Czubakowski and S. Bargu. 2008. The role of nutrient loaded freshwater pulses on phytoplankton succession and phycotoxin production in Breton Sound Estuary, Louisiana: Preliminary Observations, 2008 Northern Gulf Institute Annual Meeting, Biloxi, MS (Poster).

B. Matherne, H. Bae, J. Mire, A. Hou. 2008. Populations of *Vibrio vulnificus* and *Vibrio parahaemolyticus* in Breton Sound and Barataria Bay. 2008 NGI conference, Biloxi, MS. (Poster).

15. Personnel from this project hired by NOAA during this reporting period:

None

16. NOAA Sponsor and NOAA office of primary technical contact for this project:

Julien Lartigue, NOAA Office of Oceanic and Atmospheric Research

PROJECT 06-LSU-03: TROPHIC LINKAGES AND BIOMASS PRODUCTION IN ESTUARINE ECOSYSTEMS

1. Project Leads:

Name	*Title*	*Affiliation*	*Email*
Malinda Sutor	Project Lead	Louisiana State University	msutor1@lsu.edu
Sibel Bargu-Ates	Co-PI	Louisiana State University	sbargu@lsu.edu
Richard Shaw	Co-PI	Louisiana State University	rshaw@lsu.edu
James Cowan	Co-PI	Louisiana State University	jhcawan@lsu.edu

2. All Non-Student Personnel funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Kate Lingoni	Research Associate	BS	100	No
Ross Del Rio	Research Associate	BS	100	No
Malinda Sutor	PI	PhD	8.3	No
Sibel Bargu-Ates	PI	PhD	11	No

3. All Students funded by this project:

None

4. Project Abstract:

Higher trophic level production in estuaries is governed by the laws of trophic supply and demand 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.**

5. Key Scientific Questions/Technical Issues:

1). To determine how pulsed water regime will affect pelagic productivity and plankton community composition and biomass;

2). To determine if estuarine-dependent and/or estuarine-resident fishes assimilate a significant portion of the available carbon and nitrogen delivered to Breton Sound and Barataria Bay via high consumption rates of zooplankton and benthos, which then are exported as fish biomass at the end of the growing season (late fall-early winter).

This project is also linked to Dr. Bargu Ates' work in 06-LSU-03 "Public Health and Stressors" and the related scientific question is:

To determine the effects of nutrient loaded freshwater pulses on species community composition and phytoplankton group succession on a seasonal timescale and under varying flow regimes within Breton Sound Estuary, specifically focusing on harmful algal bloom species

6. Collaborators/Partners:

Name of collaborating organization: Louisiana Department of Wildlife and Fisheries

Date collaborating established: July 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: Louisiana Department of Wildlife and Fisheries provides data on fish population assessments in the Barataria and Breton Estuaries

7. Project Duration:

July 1, 2007 – December 31, 2010

8. Project Baselines:

Contributions to specific NOAA Goals/Objectives:

NOAA Goal 1. This project addresses the ecological function of coastal wetlands under different freshwater pulsing regimes. A greater understanding of seasonal trophic processes will help to address several issues specific to NOAA mission, namely 1) enhance our understanding and management of hazards including hurricane disturbance to cultural, economic and natural resources of coastal regions; and 2) provide information that will increase our understanding of the implications of habitat loss and better guide ecosystem management and coastal restoration in this important river delta system.

Contributions to regional problems and priorities:

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. The ecological functioning of estuarine and coastal environments in southern Louisiana is critical to assessing 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. 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.

How the project has narrowed gaps in regional knowledge, data, model performance, geographic coverage, etc.

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.

9. Objectives/Milestones accomplished in this period

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. This work is nearly complete.

We are compiling the appropriate LDWF data to compare to our plankton data. This work is being done in collaboration with a senior math class at LSU.

10. Significant research results, protocols developed, and research transitions

Our results are still preliminary, but we do have indications that a pulsed freshwater event has significant impacts on the plankton community throughout the Breton Sound estuary. The pulse appears to reduce the overall abundance and advect taxa normally found primarily in the upper estuary to the lower estuary and these changes happen in a matter of days.

11. Outreach activities

We have partnered with a senior math class at LSU to create a user-friendly program to quickly search the LDWF database and provide initial visualizations of the data. This has provided the math students with important practical skills, educated them about the science objectives of our project, and taught them more about the natural ecosystems in Louisiana.

12. Peer Reviewed Articles

None

13. Non-refereed articles and reports for this project

None

14. Conference presentations and poster presentations for this project

Sutor, M.M., M. Alford, S. Bargu Ates, R.F. Shaw, J.H. Cowan. 2008. Trophic Linkages and Biomass Production in Estuarine Ecosystems. Poster presented at 2008 NGI conference, Biloxi, MS.

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. Presented at 2009 NGI conference in Mobile, AL.

Sutor, M.M. and J. Bach. 2009. Effects of freshwater pulsing on abundance and composition of microzooplankton and phytoplankton. Presented at 2009 NGI conference in Mobile, AL.

Sutor, M.M., S. Bargu Ates, J. Czubakowski, K. Lingoni. 2010. Temporal and Spatial trends in plankton and fish community composition and primary production in two Louisiana estuary systems: Breton Sound and Barataria Bay-An Update. Presented at 2010 NGI conference in Mobile, AL.

Sutor, M.M. Mutualistic Outreach: An Educational Partnership with Undergraduates to Provide a Link between Traditional Math Skills and Ecological Data Analysis. Presented at 2010 NGI conference in Mobile, AL.

J. Czubakowski and S. Bargu. 2010. Estuarine phytoplankton response to annual and manipulated river inputs. 2010 Northern Gulf Institute Annual Meeting, Mobile, AL.

J. Czubakowski, S. Bargu and R. R. Twilley. 2009. Potentially toxic estuarine phytoplankton communities directly influenced by river input controlled by a diversion structure. Coastal and Estuarine Research Federation Biannual Conference, Portland, OR.

15. Personnel from this project hired by NOAA during this reporting period:

None

16. NOAA Sponsor and NOAA office of primary technical contact for this project:

Julien Lartigue, NOAA Office of Oceanic and Atmospheric Research

PROJECT 06-LSU-04: INVESTIGATING MATERIAL EXCHANGE BETWEEN THE MARSH AND CHANNEL ALONG AN ESTUARINE GRADIENT

1. Project Leads:

Name	*Title*	*Affiliation*	*Email*
Jaye E. Cable	PI	LSU	jcable@lsu.edu
John R. White	Co-PI	LSU	jrwhite@lsu.edu
Irving A. Mendelssohn	Co-PI	LSU	imendel@lsu.edu
Robert R. Twilley	Co-PI	LSU	rtwilley@lsu.edu

2. All Non-Student Personnel funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Joseph Baustian	RA	MS	50%	No
Fernanda Baladron	Visiting scientist from Chile	MS	0%	No

3. All Students funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Chester L. Keating IV	BS	MS	100%	No
Brett Marks	BS	MS	100%	No
Kimberly Marsh	BS	MS	75%	No

4. 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 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. 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. The Mississippi River has the highest discharge (18,400 m^3 sec^{-1}) and the largest watershed (3.3 million km^3) in North America. Using mean discharge as the metric, it is the sixth largest river in the world, yet this mighty river has been altered hydrologically to prevent the historically substantial sediment and water supplies from reaching coastal wetlands and contributing to the depositional environment. Additionally, relative sea level rise due to subsidence and eustatic changes in sea level has enhanced coastal wetland destruction. Diversions have been built along the Mississippi River corridor south of New Orleans which deliver freshwater, sediments, and nutrients to Barataria and Breton Sound estuaries. The effectiveness of these diversions as marsh sustenance tools are not clear, but biogeochemical processing occurring within estuaries as a result of fluvial discharge through these diversions may impact how deltaic marshes contribute to the coastal ocean nutrient (C, N, P) budgets. Inundation frequency and duration of marsh water levels will have a strong impact on the net retention or release of C, N and P in accreted occurring within estuaries as a result of fluvial discharge through these diversions may impact how deltaic marshes contribute to the coastal ocean nutrient (C, N, P) budgets. Inundation frequency and duration of marsh water levels will have a strong impact on the net retention or release of C, N and P in accreted organic matter. Recent studies have shown that extended low water or dry periods in a marsh can lead to a net export of nutrients as well as loss of carbon. 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 contributed to two NGI major research themes and several ongoing NOAA funded research efforts aimed at ecosystem management and climate change variability.

5. Key Scientific Questions/Technical Issues:

The scientific goal of this project was to assess impacts of rising sea level and/or fluvial inputs on C and N budgets in an hydrologically-modified deltaic estuary. We established (1) a quantitative baseline for water, C, and N cycling between the marsh and channel and (2) how this cycling contributed to marsh productivity and accretion. This working group addressed the following related questions:

How do rising sea levels and/or riverine pulses

(a) enhance carbon and nitrogen export from the wetland

(b) modify processes responsible for marsh sustainability (e.g. productivity, accretion)

The major scientific tasks of this project were to:

1. quantify material exchange of water and C and N fluxes between the marsh and channel
2. assess changes in plant productivity and role in carbon sequestration and marsh sustainability
3. identify the major biogeochemical transformation processes responsible for C and N cycling, and ultimately, long-term marsh sustainability

6. Collaborators/Partners:

Shell Oil funded DELTA observation system collaboration was established in 2007 as a one-time award to purchase equipment for field studies. No in-kind support was given. The DELTA observation system included physical, chemical, and biological information as fixed platforms and surveys (monthly) along the axis of Breton and Barataria estuaries. Our wetland material exchange study directly supported the DELTA regional modeling effort by providing much needed data for baseline calibration.

7. Project Duration:

Feb 1, 2007 – Sep 30, 2010

8. Project Baselines:

NOAA Goal 2. The project addressed carbon export to the coastal ocean in the context of climate change and rising sea levels and the increasing impact to coastal salt marsh systems. Carbon transformations and export in coastal systems is one of the greatest uncertainties in the global carbon budget. 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 had not been well understood previously. This project has allowed us to make a first order estimate of carbon fluxes from salt marshes, thus contributing to a major gap in understanding of global carbon and climate studies. The project specifically fit the NOAA mission goals to understand <u>climate variability and ecosystem management</u> due to the implications for both local-scale coastal eutrophication and the global carbon budget. Coastal wetland sustainability, nitrogen cycling, and sea level rise were addressed by evaluating their status and functioning in the Breton Sound wetlands south of New Orleans, Louisiana. The effect of hydrologic pulsing on these wetlands is of significant value to occupants of other major river systems in the world.

How the project has narrowed gaps in regional knowledge, data, model performance, geographic coverage, etc.

This project impacted the educational mission of Louisiana State University by training undergraduate and graduate students and enhancing the mission of its land-grant and sea-grant institution status. The PIs previous relationships with stakeholders (Caernarvon Interagency Advisory Committee, a diversion stakeholder group; State of Louisiana Science and Engineering Review Team) have benefited from our expertise. For example, PI Cable has had numerous discussions with the LA Department of Natural Resources about the management of the Breton Sound wetlands and is called often to discuss our research results in this study. The state is interested in the implications of the diversion and its effects on the ecosystem. We will provide the state with a copy of our results when the project is completed this year.

9. Objectives/Milestones accomplished in this period

Activity	Year 1 – 2007-08				Year 2 – 2008-09				Year 3 – 2009-10		
	JFM	AMJ	JAS	OND	JFM	AMJ	JAS	OND	JFM	AMJ	JAS
Hire personnel											
Order supplies/equipment											
Construct platforms, plots, transects											
Ongoing deployments (e.g. litter bags, sondes, Eh)											
Seasonal and experimental sampling											
Data Organization											
Data Synthesis											
Dissemination of Research Findings											

10. Significant research results, protocols developed, and research transitions

Hydrology Results:

Exchange of water and dissolved constituents between the Gulf of Mexico and coastal wetlands are expected to be greatest within the marsh-bayou system where a high proportion of sediment surface area is exposed to tidal waters. The complex geomorphology of marsh-channel networks facilitates a high rate of recharge and discharge into marsh sediments as waters flood and drain from the marsh surface. While diurnal tidal ranges were generally less than 50 cm, the low lying Louisiana deltaic coast was subject to frequent flooding caused by wind-driven tides. South Louisiana marsh water levels are dominated by wind duration and direction and the stage of the Mississippi River. Our study site is a *Spartina alterniflora* marsh in southeastern Breton Sound Basin, Louisiana, located south of Bayou Terre aux Boeuf. Within this marsh-bayou intertidal zone, we established two 20-m transects of four wells (1-, 3-, 10, and 20-m) perpendicular to the bayou, each equipped with continuously recording CTD divers. Wells were installed and screened about 1 m below the sediment surface. A surface water well equipped with a CTD diver was installed about 13 m into the marsh to measure marsh surface flooding and draining at each transect. All stations were benchmarked relative to a common datum using the USGS surface water monitoring station about 250 m downstream. Water level (e.g. pressure), conductivity, and temperature were measured hourly from September 2008 to April 2009, during which time we studied the effects of cold front passages on the pore water level response in the marsh. Cold front passages are associated with an initial strong southerly wind flow that gradually rotates into a strong northerly wind, with the south wind pushing water into the marsh and then the north wind draining it. Marsh sediment recharge/saturation times were estimated to be as high as 4 hours and were generally consistent across most measurements. This estimate yields a preliminary recharge rate of about 0.14 cm/sec. A hysteresis effect in sediment recharge and discharge was observed typically so that discharge rates, or seepage, from sediments varied over the ebb period. Contact between marsh sediments and recharge waters brought in with tides will enhance the export of dissolved constituents, such as dissolved organic carbon, as the tides retreat. During the next 40 years, predictions of sea level rise indicate the potential export of DOC as organic matter will likely increase from coastal wetlands.

Biogeochemistry Results:

Wetlands in the coastal zone are slowly becoming more saline as sea level rises over the long-term. However, a number of events in the coastal environment may lead to quick and temporary changes in the salinity of coastal marshes. Seawater driven inland by storm surges significantly increases salinity in oligohaline wetlands over the short-term (weeks). Recent large-scale efforts to restore coastal wetlands in Louisiana have utilized Mississippi River surface water diversions to re-introduce freshwater into coastal marshes, decreasing the salinity of coastal marshes. We examined the effect of salinity changes on two important nitrogen cycling processes, potential denitrification and N-mineralization, in fresh and salt marsh soils/sediments in the Breton Sound estuary, LA. All soils/sediments were subjected to freshwater and saline treatments (0-35 ppt) simulating conditions within the soil caused by an instantaneous flux of seawater due to storm surge events or high rates of freshwater flow directed by a surface water diversion. In freshwater (0 ppt) potential denitrification in fresh and salt marsh soils reached 373 ± 22.2 and 9.18 ± 3.27 mg N_2O-N kg^{-1} d^{-1}, respectively. At 35 ppt (seawater salinity), the rates were 615 ± 182 in salt marsh and 99.7 ± 21.1 mg N_2O-N kg^{-1} d^{-1} in fresh marsh soils. Potentially mineralizable N rates in fresh marsh soils at 0 and 35 ppt averaged 28.6 ± 3.71 and 38.2 ± 4.31 mg-N kg^{-1} d^{-1}, respectively. In salt marsh soils at 0 and 35 ppt, PMN rates were 12.3 ± 0.4 and 8.70 ± 0.32 mg-N kg^{-1} d^{-1}, respectively. The effects of changing salinity on N-mineralization and potential denitrification ultimately allow us to discern the mechanisms of salinity-driven influences on overall nitrogen cycling and marsh biogeochemical function. Significance of these findings are applicable to large surface water diversion projects in the coastal Florida Everglades and Mississippi River Delta, where more saline sediments are exposed to freshwater and nitrogen pulses as well as impacts of increased salinity driven into the fresh-brackish marsh from hurricanes. Sudden fluxes in salinity had short-term effects on N mineralization, while denitrification showed significant effects with sudden salinity changes in wetlands soils.

Plant Production Results:

The net retention or release of carbon, nitrogen and phosphorus in coastal wetlands is greatly impacted by both the frequency and duration of flooding. As sea levels rise, flooding in coastal wetlands is likely to increase, which could change these systems from a net sink of atmospheric carbon to a source. In order to quantify the exchange of water, C, and N between the marsh and channel, we sampled a streamside to back-marsh gradient in a Louisiana salt marsh. The gradient was divided into four zones based on elevation: a low-elevation streamside zone, a high elevation berm, a low elevation back-marsh zone, and a mid-marsh zone that had an elevation in between that of the berm and back-marsh. Measurements of belowground biomass and decomposition were made, and soil cores were taken along this same gradient. The cores were sectioned into 4 cm increments and the following parameters were measured: moisture content, bulk density, total carbon, nitrogen and phosphorus, loss on ignition, and extractable dissolved organic carbon (DOC). In addition, measurements of microbial biomass were made as microbial biomass has been related to decomposition processes in soil. Belowground biomass was lowest streamside and increased significantly toward the back-marsh. The streamside zone was also the most flooded. However, decomposition rates were not significantly different between the zones.

11. Outreach activities

Outreach is performed through participation in the NOAA sponsored Ocean Commotion Exhibition at Louisiana State University. Every year, PI Cable has volunteered five weeks of her time training 5th grade students from Westdale Heights Academic Magnet Elementary in Baton Rouge. The students are given instruction on different topics of coastal oceans and paired into small groups to perform instructive activities at the Ocean Commotion event. On the day of the event, the 5th graders host an ocean science booth visited by over 1,000 K-8 students in Louisiana.

12. Peer Reviewed Articles

None

13. Non-refereed articles and reports for this project

Keating, Chester, L. 2009. Recharge/Discharge Dynamics of Pore Waters within a Louisiana Salt Marsh in response to Water Level Changes, M.S. non-thesis report, Louisiana State University, 20 pp.

Marks, Brett W. 2010. The Effects of Salinity on Nitrogen Cycling in Wetland Soils and Sediments of the Breton Sound Estuary, LA, M.S. Thesis, Louisiana State University, 107 pp.

14. Conference presentations and poster presentations for this project

Baustian, J., Mendelssohn, I., Cable, J.E., White, J.R. The effect of hydrology on ecological functioning and material exchange between salt marshes and water bodies, Coastal and Estuarine Research Federation Meeting, Portland, Oregon, 1-5 November 2007.

Cable, J.E. and Keating, C.L. Recharge-discharge porewater dynamics of salt marsh sediments within south Louisiana, NOAA/Northern Gulf Institute Meeting, Mobile, AL, 20-21 May 2009.

Baustian, J., Mendelssohn, I., Cable, J.E., White, J., Marks, B, Keating, C. 2009. Material Exchange in a Louisiana Salt Marsh, NOAA/Northern Gulf Institute Meeting, Mobile, AL, 20-21 May 2009.

White, J.R., Cable, J.E., Mendelssohn, I.A., Mark, B., Keating, C.L., Baustian, J. Investigating material exchange along a salt marsh-channel interface, NOAA/Northern Gulf Institute meeting, Biloxi, MS, 13-15 May 2008.

Cable, J.E., White, J., Mendelssohn, I.A., Twilley, R. Investigating material exchange (DOM) from marsh to channel, NOAA/Northern Gulf Insitute meeting, Biloxi, MS, 15-16 May 2007.

15. Personnel from this project hired by NOAA during this reporting period:

None

16. NOAA Sponsor and NOAA office of primary technical contact for this project:

Julien Lartigue, NOAA Office of Oceanic and Atmospheric Research

PROJECT 06-MSU-01: DEVELOPING A FOUNDATION FOR ANALYSIS OF NATURAL AND HUMAN-INDUCED DISTURBANCES TO COASTAL ECONOMIES

1. Project Leads:

Name	*Title*	*Affiliation*	*Email*
Daniel Petrolia	PI	Mississippi State University	Drp95@msstate.edu

2. All Non-Student Personnel funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Brooklyn Anderson	Extension Associate (Mar-Apr 09	MS	4%	No
Sanjoy Bhattacharjee	Postdoctoral Research Assoc. (Dec 07 – Sept 09)	PhD	62%	No
James Harris	Research Associate (Feb – May 09)	MABM	100%	No
Tae-goun Kim	Postdoctoral Research Assoc. (Jan 08 – Jan 10)	PhD	100%	No
Guyslain Ngeleza	Postdoctoral Research Assoc. (Dec 07 – Sept 08)	PhD	100%	No
Daniel Petrolia	Assistant Professor (Feb 07 – present)	PhD	7%	No
Kelly Schaefer	Research Associate (Sept 07 – May 08)	MS	100%	No
Barry Barnett	Professor	PhD	0%	No
Keith Coble	Professor	PhD	0%	No
Garen Evans	Assistant Extension Professor	PhD	0%	No
Ardian Harri	Assistant Professor	PhD	0%	No
Al Myles	Extension Professor	PhD	0%	No
Benedict Posadas	Associate Extension Professor (MSU-CREC)	PhD	0%	No

3. All Students funded by this project:

Name	*Category (i.e., highest degree already obtained: BS, MS, PhD)*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Heather Dikes	Student worker (MSU-CREC)	HS diploma	50%	No
Will Ferraez	Student worker	HS diploma	19%	No
James Harris	Student worker	BS	12%	No
Gwan-seon Kim	Research Assistant	BS	75%	No
Jihyun Lee	Research Assistant	BS	100%	No
Augustus Matekole	Research Assistant (LSU – Ag Econ)	BS	50%	No
Ross Moore	Research Assistant	BS	100%	No

4. Project Abstract:

This project involved a series of individual research tasks, which, although independent of one another, are unified around a common theme of coastal economics. The following Task descriptions provide abstracts for each.

5. Key Scientific Questions/Technical Issues:

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.

6. Collaborators/Partners:

Name of collaborating organization: Auburn University, Terry Hanson

Date collaborating established: Aug 08

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

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

Name of collaborating organization: Center for Natural Resource Economics and Policy, John Westra and Rex Caffey

Date collaborating established: Feb 07

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

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

Name of collaborating organization: Gulf Coast Geospatial Center, Greg Carter

Date collaborating established: Feb 07

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

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

Name of collaborating organization: Economic Research Service, Andrew Muhammad

Date collaborating established: Jan 10

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

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

7. Project Duration: List the start and end date of this project (if applicable, include only *approved* No Cost Extension end date)

Feb 07 – Aug 10

8. Project Baselines:

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.

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.

How the project has narrowed gaps in regional knowledge, data, model performance, geographic coverage, etc.

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.

9. Objectives/Milestones accomplished in this period

See below.

10. Significant research results, protocols developed, and research transitions

Task 1. (completed, with manuscripts remaining in review) Non-market valuation of MS barrier-islands restoration. Lead: Petrolia 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. (completed, with manuscripts remaining in review) Non-market valuation of Louisiana coastal restoration. Lead: Petrolia. 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. Lead: Westra (LSU). 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. (completed). Assessing research needs of coastal natural disaster risk and insurance. Leads: Petrolia & Coble. Collaborator: Barnett. The objective of this task was to identify research needs related to risk and insurance. This work was conducted in collaboration with several MSU Agricultural Economics faculty (Keith Coble, Dan Petrolia, Barry Barnett), postdoctoral researchers (Guyslain Ngeleza), with Craig Landry at East Carolina University, and with former NOAA Chief Economist Rodney Weiher. Through discussions and research reviews conducted among this group, the primary research need identified was an in-depth analysis of factors that explain demand for flood insurance in the Gulf Coast, specifically with regard to how perceptions of risk (subjective vs. objective) and risk preferences (how people behave in the face of risk). The result of this research is the development of a consumer survey on flood insurance demand that will be implemented during Summer 2010. Survey costs will be covered under this task, but analysis will be conducted and funded as part of a separate NGI project ("Toward an Understanding of Gulf Coast Resident Preferences and Perceptions on Risk and Restoration"). Note also that personnel funding and subcontractor funding is not part of this task but rather as part of the other NGI project.

Task 5. (completed, with manuscripts remaining in review) Hurricane evacuation behavior analysis. Leads: Petrolia & Hanson (Auburn). 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. Lead: Evans. 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. Lead: Evans**.** 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. Lead: Evans. 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. (completed). Assess economic recovery of seafood processors and dealers, marinas, commercial harvesters, and bait dealers in coastal Mississippi. Lead: Posadas. 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). Market Integration for Shrimp and the Effect of Catastrophic Events. Leads: Harri and Muhammad. (Originally titled "Port of New Orleans impact analysis", this task was modified to its current form due to data limitations). This study employs the Prestemon and Holmes assumption that cointegration between the different shrimp markets occurs because of intertemporal arbitrage. Similarly, we assume that different shrimp markets can be defined over the "information space" as those submarkets that respond statistically in a similar way to the same information about the factors affecting shrimp demand and supply. This study also investigates the effects of Hurricane Katrina on shrimp prices in the Gulf Coast region and whether these effects are reflected in shrimp prices on the Atlantic and Pacific Coast. Preliminary results indicate that several price series from different regions/markets are cointegrated. Cointegrating relationships are found to exist between the price series of brown, pink and white shrimp from the Gulf Coast and spot shrimp from the Pacific, rock shrimp from the Gulf Coast and white shrimp from the Atlantic and brine and spot shrimp from the Pacific. An important result is the fact that price of imported shrimp is cointegrated with each of the domestic shrimp price series. This finding may have important implications regarding the relationships between the different domestic price series and the effect of catastrophic events on one series and their spillover effects.

Task 9. (completed) After the Storm – Spatial and Temporal Aspects of Business Resiliency. Lead: Evans. 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. Lead: Myles. 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 topics 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 decision makers understand how natural disasters could interrupt local economies in selected coastal counties in Mississippi.

Task 11 (ongoing). Media Coverage of Coastal Weather Events: Impacts on Attendance Levels at Northern Gulf State Parks. Lead: Morgan. 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. Lead: Morgan. 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.

11. Outreach activities

Type: Seminar

Name of event: A Web-based Socio-Economic Analysis of Human Response to Hurricanes: The Case of Several 2005 Hurricanes in Florida

Date: Aug. 13, 2007

Location: Mississippi State University

Description: A seminar was hosted in the Department of Agricultural Economics for two experts on hurricane evacuation behavior. The two presenters were Dr. Michael Thompson (Associate Professor, Economics Department, Florida A& M University) and Dr. David Letson (Associate Professor of Marine Affairs, University of Miami).

Approximate Number of Participants: 20

Type: Seminar

Date: Nov. 2, 2007

Location: Mississippi State University

Description: The presenter was Dr. Craig Landry (Assistant Professor, Department of Economics and Assistant Director, Center for Natural Hazards Research, East Carolina University).

Approximate Number of Participants: 25

Type: Presentation

Date: Jun. 4, 2008

Location: Silver Spring, MD

Description: A presentation was made at to the Chief Economist of NOAA, Dr. Rodney Weiher by 5 project members and Dr. David Shaw, NGI Director, to outline NGI economics research goals and accomplishments, and to coordinate NGI economics research with NOAA priorities and those of the Office of the Chief Economist.

12. Peer Reviewed Articles

Petrolia, D.R. and S. Bhattacharjee. “Why Don’t Coastal Residents Choose to Evacuate for Hurricanes?” Coastal Management 38(2010): 97-112.

Petrolia, D.R. and T. Kim. “What are Barrier Islands Worth? Estimates of Willingness to Pay for Restoration,” Marine Resource Economics 24(2009): 131-46.

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.

13. Non-refereed articles and reports for this project

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.

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.

Westra, J. and G. Boody. 2009. "Challenges and Necessity of Developing Multifunctional Agroecosystems”, Chapter 13 in Agroecosystem Management for the 21st Century: Integrating Production, Environment and Society. Advances in Agroecology Series edited by Patrick J. Bohlen. Boca Raton FL: CRC Press.

Westra, J. and A. Matekole. “Economic Analysis of Tillage and Nutrient Best Management Practices for Reducing Nutrient Export to the Gulf of Mexico from a Mississippi River Delta Watershed.” Proceedings from Science to Solutions: Reducing Nutrient Export to the Gulf of Mexico Workshop, Des Moines IA, Dec. 2009.

Westra, J., A. Matekole and T. Appelboom. “Bioeconomic Analysis of Nutrient Reduction Strategies in the Lower Mississippi River Basin to Address Hypoxia in the Northern Gulf of Mexico.” Proceedings of the Coastal Zone 09 Conference: Revolutionary Times: Catching the Wave of Change. Boston MA, Jul. 2009.

14. 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, Apr. 2-4.

Bhattacharjee, S., D.R. Petrolia and T.R. Hanson. “Which Forecast Factors Influence Hurricane Evacuation Decisions?” Paper Presentation, NGI Annual Meeting, Mobile AL, May 20-21, 2009.

Bhattacharjee, S., D.R. Petrolia, T.R. Hanson, and M. 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.

Evans, G. 2008. “Spatial Shift-Share Analysis of Coastal Employment Following Hurricane Katrina”. Paper Presentation, 2008 Annual Meetings of the Southern Regional Science Association.

Evans, G. and B. Anderson. 2009. “Hurricane Katrina and Spatial Patterns of Regional Specialization”. Paper Presentation, 2009 Annual Meetings of the Southern Regional Science Association, San Antonio, Apr. 2-4.

Harri, A., A. Muhammad, and K. Jones. “Market Integration for Shrimp and the Effect of Catastrophic Events.” Selected Paper prepared for presentation at the Agricultural and Applied Economics Association Annual Meeting, Denver, CO, Jul., 2010.

Harris, J.S. and K. 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.

Henderson, J. and G. Evans. “After the Storm – Spatial and Temporal Aspects of Business Resiliency”. Paper Presentation, 2009 Annual Meetings of the Southern Regional Science Association, San Antonio, Apr. 2-4, 2009.

Kim, T. and D.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, Jun. 25, 2008.

Matekole, A. and J. Westra. “Economic Analysis of Tillage and Nutrient Best Management Practices in the Ouachita River Basin, Louisiana.” Challenges of Natural Resource Economics and Policy: 3rd National Forum on Socioeconomic Research in Coastal Systems, New Orleans LA, May 2010.

Matekole, A., J. Westra and T. Appelboom. “Agricultural Drainage Management: How Economical Is It in Southern Agricultural Systems?” Southern Agricultural Economics Association, Annual Meeting, Atlanta GA, Feb. 2009.

Matekole, A., J. Westra and T. Appelboom. “Biophysical Economic Analysis of Drainage Management Systems in the Mississippi River Basin.” American Water Resources Association, Annual Meeting, New Orleans LA, Nov. 2008.

Moore, R.G., D.R. Petrolia, and T. Kim “The Effects of Climate Change Perceptions on Willingness to Fund the Prevention of Wetland Loss”, with. Selected Paper, SAEA Annual Meeting, Orlando, FL, Feb. 6-9, 2009.

Moore, R.G., D.R. Petrolia, and T. 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.

Moore, R.G., D.R. Petrolia, and T. Kim. “Preferences for Timing of Wetland Loss Prevention in Louisiana.” Oral presentation, NGI Annual Meeting, Mobile, AL, May 18-20, 2010.

Moore, R.G., D.R. Petrolia, and T. Kim. “Preferences for Timing of Wetland Loss Prevention in Louisiana.” Selected paper presentation, 3rd National Forum on Socioeconomic Research in Coastal Systems, New Orleans, May 26-28, 2010.

Morgan, K. “Local Economic Impacts of Coastal Hazards on Public Agencies.” Selected Poster, Challenges of Natural Resource Economics and Policy: 3rd National Forum on Socioeconomic Research in Coastal Systems, New Orleans LA, May 26-28, 2010.

Morgan, K. “Local Economic Impacts of Coastal Hazards on Public Agencies.” Poster, NGI Annual Meeting, Mobile AL, May 18-20, 2010.

Morgan, K. and J.S. Harris. “Impacts of Media Coverage of Coastal Weather Events on Attendance Levels at Northern Gulf State Parks.” Selected Paper, Challenges of Natural Resource Economics and Policy: 3rd National Forum on Socioeconomic Research in Coastal Systems, New Orleans LA, May 2010.

Morgan, K and J.S. Harris. “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.

Petrolia, D.R., S. Bhattacharjee, and T.R. Hanson. “Heterogeneous Evacuation Responses to Storm Forecast Attributes.” Poster, NGI Annual Meeting, Mobile, AL, May 18-20, 2010.

Petrolia, D.R., S. Bhattacharjee, and T.R. Hanson. “Heterogeneous Evacuation Responses to Storm Forecast Attributes.” Selected Poster, Challenges of Natural Resource Economics and Policy: 3rd National Forum on Socioeconomic Research in Coastal Systems, New Orleans LA, May 2010.

Petrolia, D.R., R.H. Caffey, and T. 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, D.R., R.H. Caffey, and T. Kim. “Economic Assessment of Rapid Land-Building Technologies for Coastal Restoration”, 2008 PIANC Gulf Coast Hurricane Conference: Preparedness, Response, Recovery, & Rebuilding, Mobile, AL, Nov. 13.

Petrolia, D.R. and T. Kim. “What are Barrier Islands Worth?“ Paper Presentation, NGI Annual Meeting, Mobile AL, May 20-21, 2009.

Petrolia, D.R. and T. Kim. “Are CV Stated Certainty Responses Reliable?” Paper Presentation, SERA-30 Annual Meeting, Athens GA, May 18, 2009.

Petrolia, D.R. and T. Kim. "Preventing Land Loss in Coastal Louisiana: Estimates of WTP and WTA." Selected paper presentation, 3rd National Forum on Socioeconomic Research in Coastal Systems, New Orleans, May 26-28, 2010.

Petrolia, D.R. "Investigating Public Preferences for Coastal Restoration in Louisiana and Mississippi", Coastal Restoration Enhancement through Science and Technology Workshop, Ocean Springs, MS, Mar. 8, 2010.

Petrolia, D.R. "WTP v. WTA in the context of coastal land loss in Louisiana", in "Contingent Valuation: Issues on the Frontier and in Application", Organized Symposium, SAEA Annual Meeting, Orlando, FL, Feb. 6-9, 2009.

Petrolia, D.R. "Valuing Coastal Land Resources." Departmental Seminar Series, Department of Marine Transportation Sciences, Korea Maritime University, Jan. 20, 2010.

Westra, J. and A. Matekole. "Economic Analysis of Tillage and Nutrient Best Management Practices for Reducing Nutrient Export to the Gulf of Mexico from a Mississippi River Delta Watershed." Soil and Water Conservation Society, Science to Solutions: Reducing Nutrient Export to the Gulf of Mexico Workshop, Des Moines IA, Dec. 2009.

Westra, J., A. Matekole and T. Appelboom. "Economic Analysis of Tillage and Nutrient Best Management Practices in the Ouachita River Basin, Louisiana." Agricultural and Applied Economics Association, Annual Meeting, Milwaukee WI, Jul. 2009.

Westra, J., A. Matekole and T. Appelboom. "Bioeconomic Analysis of Nutrient Reduction Strategies in the Lower Mississippi River Basin to Address Hypoxia in the Northern Gulf of Mexico." Coastal Zone 2009 (CZ 09) Meeting, Boston MA, Jul. 2009.

Westra, J., A. Matekole and T. Appelboom. "Economic Analysis of Tillage and Nutrient Best Management Practices in a Louisiana Subwatershed." Soil and Water Conservation Society, Annual Meeting, Dearborn MI, Jul. 2009.

Westra, J. "Ecosystem Services and Agricultural Lands." A Conversation about Working Wetlands. Louisiana Rice Research Station, Rayne LA, Jan. 2009.

Westra, J. and A. Matekole. "Biophysical Economic Analysis of Drainage Management Systems in the Mississippi River Basin." Northeast Agricultural and Resource Economics Association and Canadian Agricultural Economics Society, Annual Meeting, Quebec PQ Canada, Jul. 2008.

15. Has anyone from this project been hired by NOAA during this reporting period?

None

16. NOAA Sponsor and NOAA office of primary technical contact for this project:

Julien Lartigue, NOAA Office of Oceanic and Atmospheric Research

PROJECT 06-MSU-02: ASSESSING THE IMPACT OF ORDINANCES, OUTREACH AND ENFORCEMENT ON THE RESILIENCY OF GULF COASTAL WATERSHEDS

1. Project Leads:

Name	*Title*	*Affiliation*	*Email*
Jason Walker	Project Lead	Mississippi State University	jwalker@lalc.msstate.edu
Taze Fulford	Co-PI	Mississippi State University	ctf23@msstate.edu
Robert Brzuszek	Co-PI	Mississippi State University	RBrzuszek@LALC.MsState.Edu
Michael Seymour	Co-PI	Mississippi State University	MSeymour@LALC.MsState.Edu
Timothy Schauwecker	Co-PI	Mississippi State University	tschauwecker@LALC.MsState.Edu
Wayne Wilkerson	Co-PI	Mississippi State University	WWilkerson@LALC.MsState.Edu
Chris Campany	Co-PI	Mississippi State University	CCampany@lalc.msstate.edu

2. All Non-Student Personnel funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Jason B. Walker	PI	MLA	10% - Yr 1 and 3	No
Robert Brzuszek	Co-PI	MLA	0%	No
Michael Seymour	Co-PI	MLA	10% - Yr 1 and 2	No
Taze Fulford	Co-PI	MARCH	10% - Yr 1	No
Timothy Schauwecker	Co-PI	PhD	0%	No
Wayne Wilkerson	Co-PI	MLA	10% - Yr 1	No
Chris Campany	Co-PI	MLA	0%	No

3. All Students funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Kenny Langley	Grad Student	MLA	75% - Yr 1	No
Mark Levy	Grad Student	MLA	25% - Yr 1	No
Hall Roberts	Grad Student	MLA	25% - Yr 1	No
James Schepel	Grad Student	MLA	10% - Yr 3	No
Derek Nause	Grad Student	MLA	10% - Yr 3	No
Rob Anders	Grad Student	MLA	10% - Yr 3	No
Jason Arnold	Grad Student	MLA	100% - Yr 3	No
Ali Fratesi	Undergraduate	BLA	10% - Yr 3	No
Dustin Randle	Undergraduate	BLA	10% - Yr 3	No
Jamey Matte	Undergraduate	BLA	10% - Yr 3	No

4. 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.

5. Key Scientific Questions/Technical Issues:

The NGMCI 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.

6. Collaborators/Partners:

Name of collaborating organization: Weeks Bay NERR

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 NERR

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 assisted in planning and organizing a similar workshop held at Grand Bay NERR on 12/10/2009.

Name of collaborating organization: The 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, assisted in the planning and organization of a workshop held at the Mississippi Water Resources Conference, August 5-7 in Tunica, MS.

7. Project Duration:

Project duration is three years, 1/2007 – 6/2010

8. Project Baselines:

Contributions to specific NOAA Goals/Objectives:

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

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".

Contributions to regional problems and priorities:

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

How the project has narrowed gaps in regional knowledge, data, model performance, geographic coverage, etc.

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.

9. Objectives/Milestones accomplished in this period

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.

Task 6. Analyze pilot data. Task complete.

Task 7. Expand research area. Task complete.

Task 8. Coordination and Reporting. Task complete.

10. Significant research results, protocols developed, and research transitions

Conclusions drawn from workshop surveys:

The researchers used a visual survey to record workshop participants preferences on a range of conventional (curb and gutter, paved swale, conveyance pipe, and so on) and innovative stormwater facility techniques (green roofs, rain gardens, vegetated swales, porous paving, green streets, and so on). The visual survey consisted of fifty images. Survey respondents ranked each image using a Likert scale (1-5), from least desirable (1) to most desirable (5). The findings reveal that people have a range of preferences for conventional and innovative strategies. As a group, the conventional strategies where *less preferred* than the innovative facilities. However, the analysis shows that within the innovative strategies, there appears to be a visual preference of some techniques over other strategies.

Our study showed that some within the design and public policy community in Alabama and Mississippi are unclear as to the effects of some land uses on water quality. General knowledge among our study group indicated that there is agreement that point sources, development, and agriculture make very significant contributions to water quality impairment. There is far less consensus in this group, however, about the impact of urban and suburban areas on water quality, at least in this study area. This would seem to indicate that with further education showing evidence of the urban and suburban impacts, this group would readily accept and promote measures to increase the effectiveness of water quality measures in these areas. Therein lies the importance of the workshops that were conducted. The notion of decentralizing stormwater treatment, making it more aesthetic and treating water as an amenity rather than a nuisance is new to the decision-makers in the study area. Participants in general seemed open to these new ideas.

Our results indicated that newer stormwater technologies are misunderstood by some in the design and policy professionals. Lack of knowledge regarding green roof effects on water runoff volume was the best example of the need to communicate exactly what to expect from the various stormwater strategies that are available to designers and policy makers. This was not the only example, however, and if the hope is to see more creative approaches to stormwater design at smaller scales, then design guidelines will need to be disseminated so that potential solutions can be evaluated based on volume reduction and pollutant removal efficiencies. To our knowledge, no such manuals specific to this study area exist.

The number of study subjects rating their local water quality as good was higher than expected, as was the low number of participants assigning a low rating. This study group represented well-educated professionals that we assumed would be aware of the problems that exist with our water resources. The USEPA ranking of water resources in this region do give higher marks (fair) for water quality than for sediment quality, benthic quality, and coastal habitat quality, which all received poor ratings. Continued impairment of these other ecological indicators would not bode well for other parameters such as water quality, especially in the face of increased development in these coastal areas. If the general public is to be expected to adopt water quality measures at the site scale, they will need to be informed of the issues and potential solutions by the people attending this type of workshop. Again, this underscores the value of bringing new techniques to the fore.

Conclusions drawn from an analysis of Covington, LA water quality policy and water quality:

Analysis of data in this research effort allowed the researcher to isolate certain factors among various water quality parameters recorded in 2002, 2003, and 2004, in many cases and among land use changes over a four year period. Analysis completed on local policy before this study began was used to summarize the state of local law in terms of water quality so that improvements could be suggested. Simultaneous consideration of these three components allows for an overall analysis of how local policy is impacting land use and water quality in this small city.

Analysis of water quality policy for the City of Covington, Louisiana revealed that it had very little governance in place to prevent water quality degradation. Only references to new subdivision stormwater drainage systems and cut or fill requirements to prevent flooding were found (Walker et al. 2008). While there were no pervious or impervious-specific laws included in the code, there were lot size requirements and minimum setback standards that determined how much of a lot can be developed. This existing policy could provide a very minimal framework for additional, more stringent policy in the future.

Land use change analysis for the city revealed that impervious cover rose from 2001 to 2005. While there were also some potentially beneficial shifts in land use in regards to water quality, it was overshadowed by the fact that impervious cover for the city continued to rise. This occurred through converting some natural areas to varying intensities of development or increasing the intensity of preexisting development.

Water quality for selected sites provided a snapshot of conditions found mainly during the year of 2004. Levels indicated that conditions were poor in many channels before surface water entered the city. Once it passed through town, some parameters showed increased levels of impairment, while others fell slightly or stayed the same. All selected points with the exception of one took readings for levels along surface water systems that would have drained land from outside the City of Covington. For this reason, it must be said that while land use change and policy were analyzed exclusively for the City of Covington, monitoring for most sites included factors originating beyond the influence of the city. Regardless of water quality changes, surface water in and around Covington was most certainly impaired. Covington and St. Tammany Parish should be working with the state to implement measures that seek to reduce pollutant discharges.

Overall, it was found that Covington lacks a coherent and organized water quality improvement strategy in its Code of Ordinances. This lack of policy appears to be leading to unchecked development occurring within its boundaries. Matters are complicated by the fact that development is occurring just outside its limits, but are dependent on Covington’s citizens and other resources for survival. So while impervious cover in and around the city increase, water quality is obviously suffering. Out of the 14 sites selected for analysis, all of them were polluted with E. coli levels that far exceeded published standards and many were impaired for dissolved oxygen and turbidity. Hopefully elected officials will begin to listen to support organizations like the Lake Pontchartrain Basin Foundation, who are working with St. Tammany Parish and the City of Covington to improve water quality related policy.

Conclusions drawn from evaluation of NGO activity in study watersheds:

The variation in NGO outreach programs between our four study watersheds may be due to the uniqueness of watershed land uses, and may provide some speculative rationale for the differences in program efforts. The New River/Apalachicola (FL) watershed contains large portions of the Apalachicola National Forest and the Tates Hell State Forest. Because of the extent of these national and state lands, efforts in regards to restoration, conservation, and management may be precluded within that watershed, allowing for development review and education. Similarly, in Alabama the Weeks Bay National Wetland Estuarine Reserve lies within the Fish watershed, perhaps providing more central focus for broadly diverse efforts without a primary focus. In the rapidly growing population areas within the Tchefuncte and Bogue Falaya (LA) watersheds, watershed management may be a more priority issue. With the large of amount of lands in private holdings within the Biloxi watershed (MS), land management, restoration efforts, and conservation easements may be one avenue of working with landowners to improve water quality and riparian habitat. The frequency results reveal that the area of focus for program efforts in the Northern Gulf of Mexico lie in the areas of policy (73% of total programs), education (77%), and development review (73%). The lowest responses for program areas in this region identified management planning (32%), land management (32%), water quality monitoring (36%), and restoration projects and implementation (36%). The overall efforts in this region reflect priorities in broad based objectives such as policy and education and less response to site-specific actions.

Evaluating existing programs to determine watershed efforts is an important part of constructing new program priorities. The results from our study indicate that programs can vary regionally across watersheds due to individual issues. Assessing program priorities in a regional light helps to determine real and perceived program needs for separate watersheds. Creating an inventory of existing programs allows for an understanding of watershed priorities and reveals which efforts are already being implemented. Understanding individual watershed efforts reveals opportunities to diversify program types and stakeholders not addressed. A method that includes surveying and identifying watershed program efforts for multiple watersheds in a region and comparing their program priorities, allows for a larger view of understanding regional watershed programming and identifies areas for future programming needs. Extension personnel working with developing programs in a watershed should evaluate non-governmental organization program efforts within their watershed and adjacent watersheds to determine program areas already utilized to prevent duplication of efforts. Looking at precedents of program types and stakeholders in other regions will help define new areas for program improvement.

11. Outreach activities

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 were elected officials, planners, developers, NGO personnel, Coastal Training Program Coordinators from NOAA NERRs, and other NGI researchers.

Workshops included 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.

Date: 11/18-19/2008

Location: Five Rivers, 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

Date: 12/8/2008

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

Date: 8/6/2009

Location: Mississippi Water Resources Conference, Tunica, MS

Description: Workshop covered similar content to the previously conducted workshops.

Approximate Number of Participants: 18-25

Date: 12/10/2009

Location: Grand Bay NERR, Moss Point, MS

Description: Workshop covered similar content to the previously conducted workshops.

Approximate Number of Participants: 20-25

12. Peer Reviewed Articles

Schauwecker, T.J, Walker, J.B., Fulford, C.T., and Seymour, M. 2010. The water looks clean: public perception of water quality and stormwater design techniques in Mississippi and Alabama. *Council of Educators in Landscape Architecture Proceedings, 1-8.*

Brzuszek, R., Fulford, T., Roberts, H., Schauwecker, T 2009. Comparison of Water Quality Program Efforts for Non-Governmental Organizations within Northern Gulf of Mexico Watersheds. Journal of Extension. 47(6). Available electronically at http://www.joe.org/joe/2009december/rb6.php

13. Non-refereed articles and reports for this project

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.

14. Conference presentations and poster presentations for this project

Walker, J.B., Fulford, C.T., Seymour, M., and Schauwecker, T.J. 2010. Is that visually desirable? A perception study of stormwater management facilities. Presented at the Council of Educators in Landscape Architecture (CELA) Annual Conference, Maastricht, the Netherlands.

Schauwecker, T.J, Walker, J.B., Fulford, C.T., and Seymour, M. 2010. The water looks clean: public perception of water quality and stormwater design techniques in Mississippi and Alabama. Presented

at the Council of Educators in Landscape Architecture (CELA) Annual Conference, Maastricht, the Netherlands.

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.

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.

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.

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

Walker, J.B., Schauwecker, T., Seymour, M., Wilkerson, G.W., Fulford, C.T., and Langley, K. 2007. Assessing the impact of ordinances, outreach and enforcement on the resiliency of gulf coastal watersheds. Presented at the Annual Northern Gulf Institute Conference. Biloxi, Mississippi.

15. Personnel from this project hired by NOAA during this reporting period:

None

16. NOAA Sponsor and NOAA office of primary technical contact for this project:

Julien Lartigue, NOAA Office of Oceanic and Atmospheric Research

PROJECT 06-MSU-03: WATERSHED MODELING IMPROVEMENTS TO ENHANCE COASTAL ECOSYSTEMS

1. Project Leads:

Name	*Title*	*Affiliation*	*Email*
William H. McAnally	PI	Mississippi State University	mcanally@cee.msstate.edu
Jairo N. Diaz-Ramirez	Co-PI	Mississippi State University	jd216@cee.msstate.edu

2. All Non-Student Personnel funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
William H. McAnally	PI, Research Professor	PhD	8	No
Jairo N. Diaz-Ramirez	Co-PI, Assistant Research Professor	PhD	100	No
Gary Ervin	Associate Professor	PhD	10	No
Christopher Brooks	Assistant Professor	PhD	10	No
Vladimir Alarcon	Assistant Research Professor	PhD	25	No
Wayne Wilkerson	Associate Professor	MLA	8	No
Sandra Ortega	Research Associate	MS	50	No

3. All Students funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Gray Turnage	BS	MS	100%	No
Matt Roberts	BS	MS	40%	No

4. Project Abstract:

The goal of this project was improved watershed-wide decision support for resource management agencies. Improved hydrologic and water quality data collection, analysis, and simulation tools were demonstrated on selected catchments of the Mobile River and Weeks Bay watersheds. The following interconnected processes were evaluated in this study: rainfall-runoff generation; sediment yield; phosphorus transport; stream bank erosion; best management practices; and habitat response. There were 56 major project products including: 6 peer-reviewed journal articles, 7 peer-reviewed conference proceedings, 6 conference proceedings, 12 reports, 2 MS thesis, 28 conference papers & posters, and a course outline.

5. Key Scientific Questions/Technical Issues:

Improved watershed-wide decision support for resource management agencies.

6. Collaborators/Partners:

Name of collaborating organization: US 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: US Army Corps of Engineers, Engineer R&D Center

Date collaborating established: Jun 2007

Does partner provide monetary support to project? Amount of support? None

Does partner provide non-monetary (in-kind) support? Part reimbursed, part in-kind support (signed agreements)

Short description of collaboration/partnership relationship: Shared models, training of Corps' models

Name of collaborating organization: US Department of Agriculture, National Sediment Lab

Date collaborating established: Dec 2007

Does partner provide monetary support to project? Amount of support? None

Does partner provide non-monetary (in-kind) support? Part reimbursed, part in-kind support (signed agreements)

Short description of collaboration/partnership relationship: Shared models, data, training on models and field operations

7. Project Duration:

Feb 2007 to Jan 2010

8. Project Baselines:

Contributions to specific NOAA Goals/Objectives:

This project satisfied NOAA Mission Goal 1: Protect, Restore, and Manage Use of Coastal and Ocean Resources Through Ecosystem-Based Management. It also contributed 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 contributed 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."

Contributions to regional problems and priorities:

This project contributed 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.

How the project has narrowed gaps in regional knowledge, data, model performance, geographic coverage, etc.

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

9. Objectives/Milestones accomplished in this period

Basin and Data Testing: Hydrologic Simulation Program FORTRAN (HSPF)

Freshwater inflows into the Weeks Bay were simulated using the HSPF model. The study area is located in the Baldwin County, Alabama and covers around 198 mi^2 of land surface. The watershed model was divided into 42 sub-catchments. The model was setup using NOAA hourly rainfall data from 2002 to 2008. Simulated daily streamflow was evaluated against USGS 02378500 Fish River and 02378300 Magnolia River. The hydrology performance of the Fish River model was better than that for the Magnolia River one. Magnolia River and Fish River sub-catchment models performed better for the wet season (2003-2005) than the dry season (2006-2008). For the 2003-2008 periods, the simulated average daily freshwater inflow into the Weeks Bay was 441 cfs.

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

The objective of this work was to add groundwater simulation capability to an existing GSSHA overland flow model as well as update the existing surface-water parameters. The study area is on the Magnolia River basin above USGS gage #02378300 located near Foley, Alabama at lat 30˚ 48´ 05˝, long 117˚ 12´ 19˝. The drainage area is approximately 44.7 km^2 and consists mostly of agricultural and developed land. The quantitative and qualitative comparisons between simulated and observed streamflow data conclude that the model can simulate wet-season peaks in surface water runoff as well as the groundwater dominated base flow during drier periods. Although more validation and longer simulations will be needed in the future, the model effectively simulates the interaction between groundwater and surface water.

Data Collection and Analysis: Evaluation of sediment processes in Town Creek watershed

Sediment processes were 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.

10. Significant research results, protocols developed, and research transitions

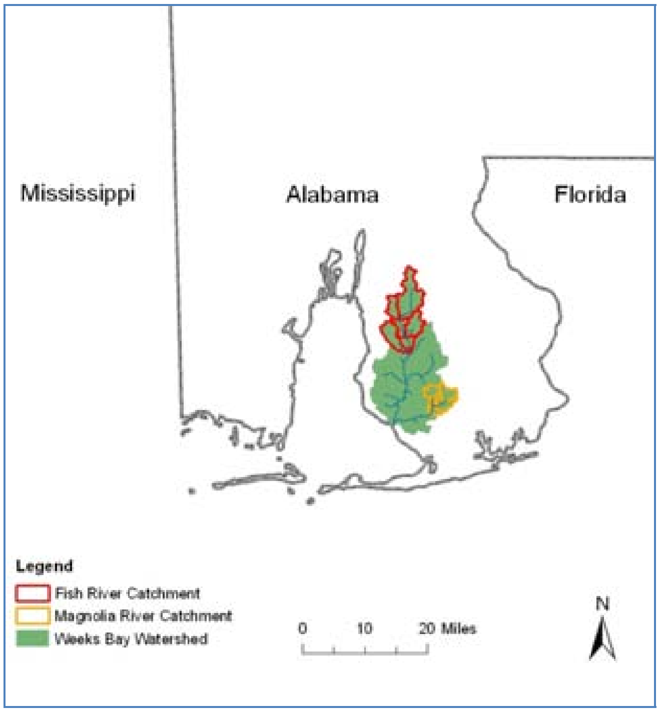


Figure 20. Location of the Weeks Bay watershed and USGS gaged catchments.

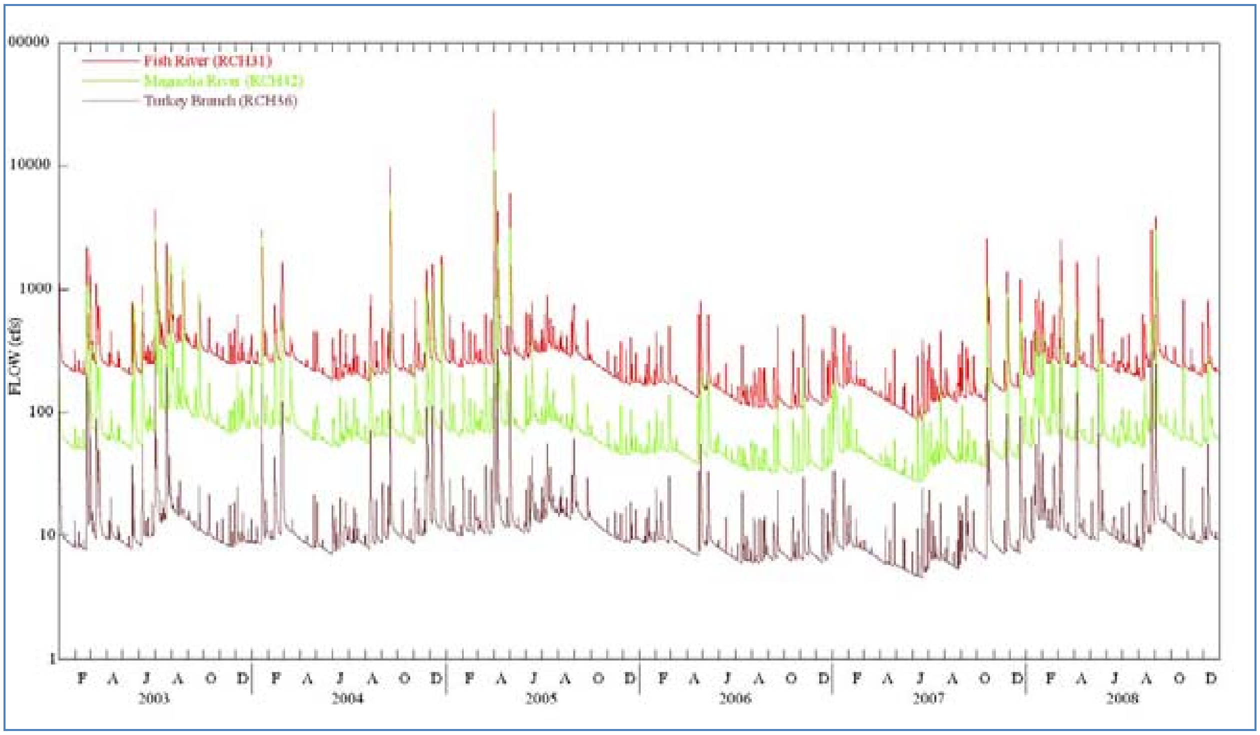


Figure 21. HSPF Streamflow simulations coming into the Weeks Bay.

Figure 22. Pin erosion plots to determine streambank erosion rates at Town Creek, MS

Figure 23. Surveyed cross sections to determine streambank erosion and bank instability at Yonaba Creek, MS

11. Outreach activities

Project staff made multiple presentations at state (e.g. Mississippi Water Resources Associations and), regional (e.g. Alabama Water Resources Conference), national (e.g., World Environmental and Water Resources Conference, American Society of Agricultural and Biological Engineers Annual International Meeting, Federal Interagency Sedimentation Conference), and international meetings (21st Century Watershed Technology Conference: Improving Water Quality and the Environment in Costa Rica) 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 December 1, 2009 we attended the Weeks Bay Monitoring Design Workshop in Weeks Bay NERR, AL to show the studies done by our team in that area. We developed a watershed management course outline that will become a teaching tool for all agencies involved in water and land resources management.

12. Peer Reviewed Articles

Wilkerson G.W., W.H. McAnally, J.L. Martin, J.A. Ballweber, K. Collins Peavy, J. Diaz-Ramirez, and A. Moore. 2010. Latis: A Spatial Decision Support System to Assess Low Impact Site Development Strategies. Hindawi Publishing Corporation, Advances in Civil Engineering, Article ID 810402, 18 pages, doi:10.1155/2010/810402. http://www.hindawi.com/journals/ace/2010/810402.html

Diaz-Ramirez, J. N., V. Alarcon, Z. Duan, M. L. Tagert, W. H. McAnally, J. L. Martin, and C. G. O'Hara. 2008. Impacts of Land Use Characterization in Modeling Hydrology and Sediments for the Luxapallila Creek Watershed, Alabama/Mississippi. Transactions of the ASABE 51(1): 139-151.

13. Non-refereed articles and reports for this project

Ramírez-Avila, J. J. 2010. Suspended Sediment Transport in a Southeastern Plains Ecoregion Watershed. 2010 Environmental and Water Resources Engineering National Student Technical Paper Contest. 1st Place.

Ramírez-Avila, J. J., E. J. Langendoen, W. H. McAnally and S. L. Ortega-Achury. 2010. A Sediment Budget for Town Creek Watershed: Suspended Sediment Transport Rates Analysis. Proceeding of the 2010 Federal Interagency Sedimentation Conference (FISC).

Ramírez-Avila, J. J., E. J. Langendoen, W. H. McAnally, J. L. Martin, S. L. Ortega-Achury. 2010. Assessment and Estimation of Streambank Erosion Rates in the Southeastern Plains Ecoregion of Mississippi. Proceeding of the 2010 Federal Interagency Sedimentation Conference (FISC).

Ramírez-Avila, J. J., E. J. Langendoen, W. H. McAnally, J. L. Martin, S. L. Ortega-Achury and J. Diaz-Ramirez. 2010. Streambank Erosion Assessment in Southeastern Plains Ecoregion Channels Using in Situ Monitoring and Submerged Jet Testing. Proceeding of the 2010 ASCE-EWRI Annual Meeting.

Ramírez-Avila, J. J. 2009. Evaluation and Prediction of Sediment and Phosphorus Loads Within the Town Creek Watershed, MS. 2009 Northern Gulf Institute Annual Conference. Student Paper Contest. 2nd Place.

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

Diaz-Ramirez, J. N., W. H. McAnally, J. L. Martin. 2010. A Review of HSPF Evaluations on the Southern United States and Puerto Rico. 21st Century Watershed Technology: Improving Water Quality and the Environment. February 21-24, Costa Rica. Meeting of the ASABE and EARTH 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.

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

Ortega-Achury, S. L., J. J. Ramírez-Avila, W. H. McAnally and J. L. Martin. 2009. Nutrient and Sediment Production, Watershed Characterization, and Land Use in the Town Creek Watershed, Mississippi. 2009 ASABE Annual International Meeting. Reno, NV.

Ervin, G. N., C. P. Brooks, and V. Alarcon. 2010. Exploring Biologically Relevant Buffer Zones for Aquatic and Wetland Ecosystems in Northern Mississippi. Proceedings of the Mississippi Water Resources Conference, August 5-7, 2009, K. Brasher, ed., Mississippi State University, pp. 84-94.

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

Diaz-Ramirez, J. N., B. E. Johnson, W. H. McAnally, and J. L. Martin. 2010. Multidimensional and Lumped Overland Flow Modeling: A Study Case. NOAA - Northern Gulf Institute, MSU, MS.

Diaz-Ramirez, J. N., W. H., McAnally, and J. L. Martin. 2010. Weeks Bay Watershed Hydrology Simulation. NOAA - Northern Gulf Institute, MSU, MS.

McAnally, W. H., J. L. Martin, J. N. Diaz-Ramirez, A. J. Allen, A. E. Myles, G. W. Wilkerson, J. Cartwright, R. Jackson, V. Alarcon, P. Amburn, M. L. Tagert, J. Baca, B. Hsieh, S. C. Sanborn, C. M. Wallen, and J. A. Ballweber. 2009. Sulis: A Framework for Healthy Watersheds – Healthy Oceans –Healthy Ecosystems. NOAA - Northern Gulf Institute, MSU, MS.

McAnally, W. H., V. J. Alarcon, P. Amburn, J. A. Baca, J. A. Ballweber, J. H. Cartwright, G. N. Ervin, R. E. Jackson, J. Martin, S. L. Ortega-Achury, J. J. Ramirez-Avila, and G. W. Wilkerson. 2009. White Paper: Holistic Water Resources Management, a Professional Education Plan. Mississippi State University: Northern Gulf Institute.

Ervin, G. N. 2009. Relationship of Wetlands Vegetation and Land Cover as an Indicator of Ecologically Appropriate Wetland Buffer Zones. NOAA - Northern Gulf Institute, MSU, MS.

Ramírez-Avila, J. J., W. H. McAnally, J. L. Martin. 2010. Tennessee -Tombigbee Waterway: One Dimensional Hydraulic Model. HEC-RAS model application. Mississippi State University: Northern Gulf Institute.

McKee, J. K., and W. H. McAnally. 2009. Evaluation of Erosional Forcings of a Beach/Berm/Wetland System and Applicable Restoration Technologies. Mississippi State University: Northern Gulf Institute Report.

McKee, J. K., and W. H. McAnally. 2009. Water Budget of Tombigbee River – Tenn-Tom Waterway from Headwaters to Junction with Black Warrior River. Mississippi State University: Northern Gulf Institute Report.

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.

McKee, J. K. 2009. Water Budget of Tombigbee River – Tenn-Tom Waterway from Headwaters to Junction with Black Warrior River. MS Thesis, Civil and Environmental Engineering, Mississippi State University.

Sharp, J. A. 2008. Sediment Budget Template Applied to Aberdeen Pool. MS Thesis, Civil and Environmental Engineering, Mississippi State University.

14. Conference presentations and poster presentations for this project

Diaz-Ramirez, J. N., W. H. McAnally, and J. L. Martin. 2010. Hydrological Modeling of Coastal Catchments in Alabama. Northern Gulf Institute Annual Conference, Mobile, May 18-20. Meeting of the Northern Gulf Institute, MSU, MS.

Diaz-Ramirez, J. N., B. E. Johnson, W. H. McAnally, and J. L. Martin. 2010. Comparison of Lumped and Distributed Hydrologic Models for the Runoff Simulation of a Large Watershed in Alabama and Mississippi. Northern Gulf Institute Annual Conference, Mobile, May 18-20. Meeting of the Northern Gulf Institute, MSU, MS.

McAnally, W. H., J. Cartwright, R. Jackson, J. L Martin, and J. N. Diaz-Ramirez. 2010. Sulis - A Tool for Healthy Watersheds, Healthy Oceans, Healthy Ecosystems. Northern Gulf Institute Annual Conference, Mobile, May 18-20. Meeting of the Northern Gulf Institute, MSU, MS.

Diaz-Ramirez, J. N., W. H. McAnally, J. L. Martin. 2010. A Review of HSPF Evaluations on the Southern United States and Puerto Rico. 21st Century Watershed Technology: Improving Water Quality and the Environment. February 21-24, Costa Rica. Meeting of the ASABE and EARTH University.

Diaz-Ramirez, J. N. and K. McNeal. 2009. Physical Assessment of Weeks Bay. Weeks Bay Monitoring Design Workshop, December 1, Weeks Bay NERR, AL.

Follum M., J. Sharp, and J.N. Diaz-Ramirez. 2009. Numerically Modeling the Magnolia River Basin in Baldwin County, Alabama. Northern Gulf Institute 5-Year Review, October 7-8, High Performance Computing Collaboratory, Mississippi State University, MS. [Poster]

Diaz-Ramirez, J. N., V. Alarcon, and W. H. McAnally. 2009. Modeling Hydrology of the Weeks Bay Watershed. Alabama Water Resources Conference, September 9-11, Perdido Beach Resort, Orange Beach, Alabama.

Diaz-Ramirez, J. N., B. E. Johnson, W. H. McAnally, and J. J. Ramirez-Avila. 2009. Runoff Modeling of the Luxapallila Creek Watershed Using Gridded and Lumped Models. Mississippi Water Conference, Tunica, MS, August 5-7. Meeting of the Mississippi Water Resources Research Institute, MSU, MS.

Ramírez-Avila, J. J., E. J. Langendoen, W. H. McAnally, J. L. Martin, S. L. Ortega-Achury, and J. N. Díaz-Ramírez. 2009. Identification of Streambank Erosion Processes and Channel Changes in Northeastern Mississippi. Mississippi Water Conference, Tunica, MS, August 5-7. Meeting of the Mississippi Water Resources Research 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. 2009. Presented at the Northern Gulf Initiative (NGI) Conference. Mobile, AL. May 19-21.

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. 2009. Presented at the Council of Educators in Landscape Architecture (CELA) Conference. Tucson, Arizona. January 14-17.

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.

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].

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, 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].

Turnage, G., C. P. Brooks, J. N. Diaz-Ramirez, and 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]

Ervin, G. N., C. P. Brooks, and V. Alarcon. 2009. Exploring Biologically Relevant Buffer Zones for Aquatic and Wetland Ecosystems in Northern Mississippi. Mississippi Water Resources Conference, Tunica, MS, August 5-7.

Diaz-Ramirez, J. N. 2008. Weeks Bay Studies. Project Implementation Committee Meeting, 5 Rivers Delta Center, AL, December 11. Mobile Bay National Estuary Program.

Moore, A. and W. Wilkerson. 2008. Do We Really Need Another Model: Designing a Tool to Assess the Effectiveness of Best Management Practices. AWRA Annual Water Resources Conference. New Orleans, Louisiana. November 17-20.

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].

Diaz-Ramirez, J. N., J. L. Martin, and W. H. McAnally. 2008. Current Research Projects in the Water Resources Area at MSU-CEE. Meeting with the faculty, staff, and students of the Universidad Nacional de Colombia, College of Engineering and Department of Civil & Agricultural Engineering, August 11. Bogota, Colombia [In Spanish].

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

Ramírez-Avila, J. J., J. N. Diaz-Ramirez, J. L. Martin, and W. H. McAnally. 2008. Sediment Transport Analysis Using HEC-RAS 4.0. Annual Mississippi Water Resources Conference, Jackson, MS, April 15-16. Meeting of the Mississippi Water Resources Research Institute, MSU, MS.

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

Bried, J. T. and G. N. Ervin. 2008. Making Invasiveness Count in Floristic Quality Assessments. Society of Wetland Scientists, Washington, DC, May 26-30.

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

Ervin, G. N. and C. P. Brooks. 2007. Ecosystem Response Models. Mobile Bay Collaboration Network Workshop, Dauphin Island Sea Lab, Alabama, 06 November.

Ervin, G. N. 2007. A Multi-Scale Examination of the State of Our Understanding in Hydrophyte Ecology. 30th Congress of the International Association of Theoretical and Applied Limnology, Montreal, Canada, 12-18 August.

15. Personnel from this project hired by NOAA during this reporting period:

None

16. NOAA Sponsor and NOAA office of primary technical contact for this project:

Julien Lartigue, NOAA Office of Oceanic and Atmospheric Research

PROJECT 06-MSU-04: SPATIAL TECHNOLOGY AND HIGH PERFORMANCE COMPUTING FOR IMPROVING PREDICTION OF SURFACE WATER QUALITY

1. Project Leads:

Name	*Title*	*Affiliation*	*Email*
William H. McAnally	PI	Mississippi State University	mcanally@ngi.msstate.edu
Vladimir Alarcon	Co-PI	Mississippi State University	alarcon@gri.msstate.edu
John Cartwright	Co-PI	Mississippi State University	johnc@ngi.msstate.edu

2. All Non-Student Personnel funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
William McAnally	PI, Associate Professor	PhD	0%	No
Vladimir Alarcon	Co-PI, Assistant Professor	PhD	75%	No
John Cartwright	Co-PI, Research Associate	MS	75%	No
Rita Jackson	Research Associate	MS	0%	No

3. All Students funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Wali Aziz	BS	MS	100%	No
Jared McKee	BS	MS	50%	No
Richard McComas	BS	MS	50%	No
Jeremy Sharp	BS	MS	50%	No

4. Project Abstract:

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

5. Key Scientific Questions/Technical Issues:

Develop and demonstrate the use of advanced spatial technology and high performance computing capabilities in the prediction of surface water quality. This includes the utilization of this technology for effective means of information transfer to a wide range of users with various degrees of technical capabilities.

Current water resources software use, by default, standard land use, topographical, and meteorological datasets. More current land use data (such as MODIS MOD 12Q1) require extensive geo-processing for their introduction into water resources models. Distributed rainfall datasets (such as NEXRAD) also require processing for their conversion into time-series as required by water resources models. That is also valid for NOAA coastline and bathymetry data.

The ubiquitous use of the Windows operating system has forced current water resources models to be compiled and used within the Windows environment. However, in order for those computer programs to be run in a high performance computing facility (cluster), the programs have to be recompiled into the Unix/Linux operating system. Likewise, current codes that run in Windows are sequential and require extensive changes for them to be parallelized.

6. Collaborators/Partners:

Name of collaborating organization: US Army Corps of Engineers, Engineer R&D Center

Date collaborating established: Jun 2007

Does partner provide monetary support to project? Amount of support? None

Does partner provide non-monetary (in-kind) support? Part reimbursed support, part in-kind support (signed agreements)

Short description of collaboration/partnership relationship: Shared models, training on Corps' models

7. Project Duration:

Feb 2007 – Jan 2010

8. Project Baselines:

Contributions to specific NOAA Goals/Objectives:

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

Contributions to 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.

How the project has narrowed gaps in regional knowledge, data, model performance, geographic coverage, etc.

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.

9. Objectives/Milestones accomplished in this period

- Development of Mesh Generation and Refinement Tool (MGRT)
- Development of 2-D computational grids for Mobile Bay
- Benchmarking with HPC for surface water modeling applications (ADH)
- Framework for a watershed analysis and reporting system
- Spatial Watershed Erosion System (SWES)
- Geoprocessing of NEXRAD data for improvements to surface water models
- Framework for watershed decision support system (Sulis)
- Light GIS applications with Google Earth for information transfer
- Spatial data library for Mobile Bay basin
- Online Mapping applications for watershed data management and analysis
- Geoprocessing of MODIS MOD 12Q1 land use for assimilation into water resources models
- Development of expertise and methodologies for compiling the ADH code in HPCC clusters.
- Development of expertise for parallelizing Fortran and C water resources codes.
- Development of expertise in generation of hydrodynamic models using the Adaptive Hydraulic system (ADH).
- Development of expertise of using the Surface-water Modeling System (SMS)

10. Significant research results, protocols developed, and research transitions

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 24). 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.

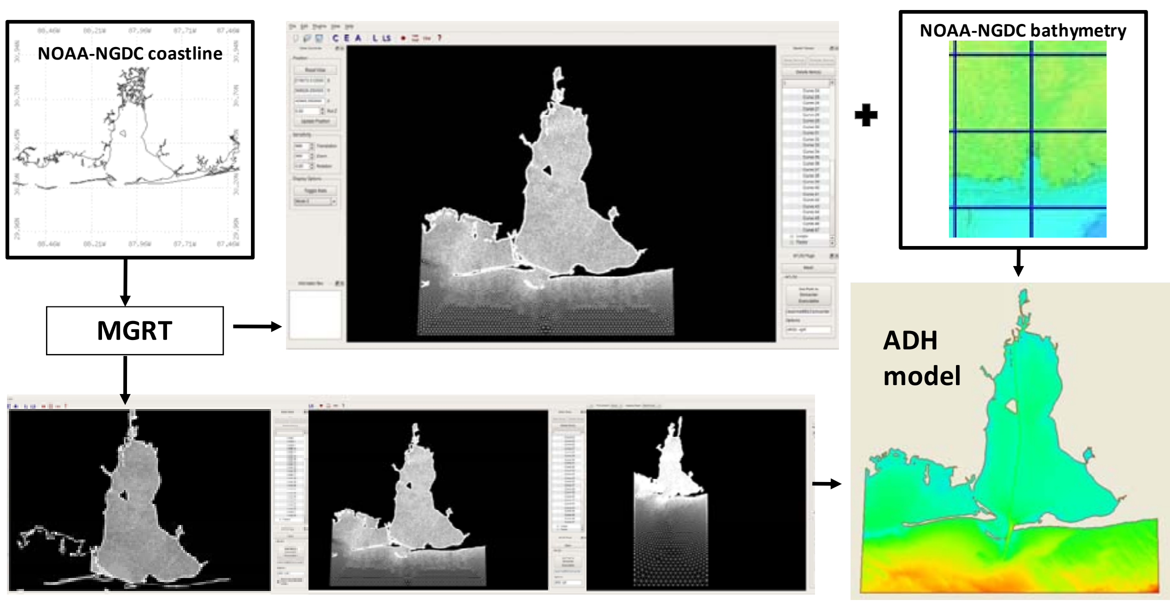


Figure 24. NOAA coastline data is introduced into MGRT to produce several 2-D computational grids for Mobile Bay. SMS is used to add bathymetric information and perform initial set-up of corresponding ADH hydrodynamic models.

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 25 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 25). Following these results, a preliminary hydrodynamic calibration of the model applications was performed (Figure 26).

$$Speed\ \ Up = S_p = \frac{Time\ \ 1\ \ processor}{Time\ \ N\ \ processors} = \frac{T_1}{T_N}$$

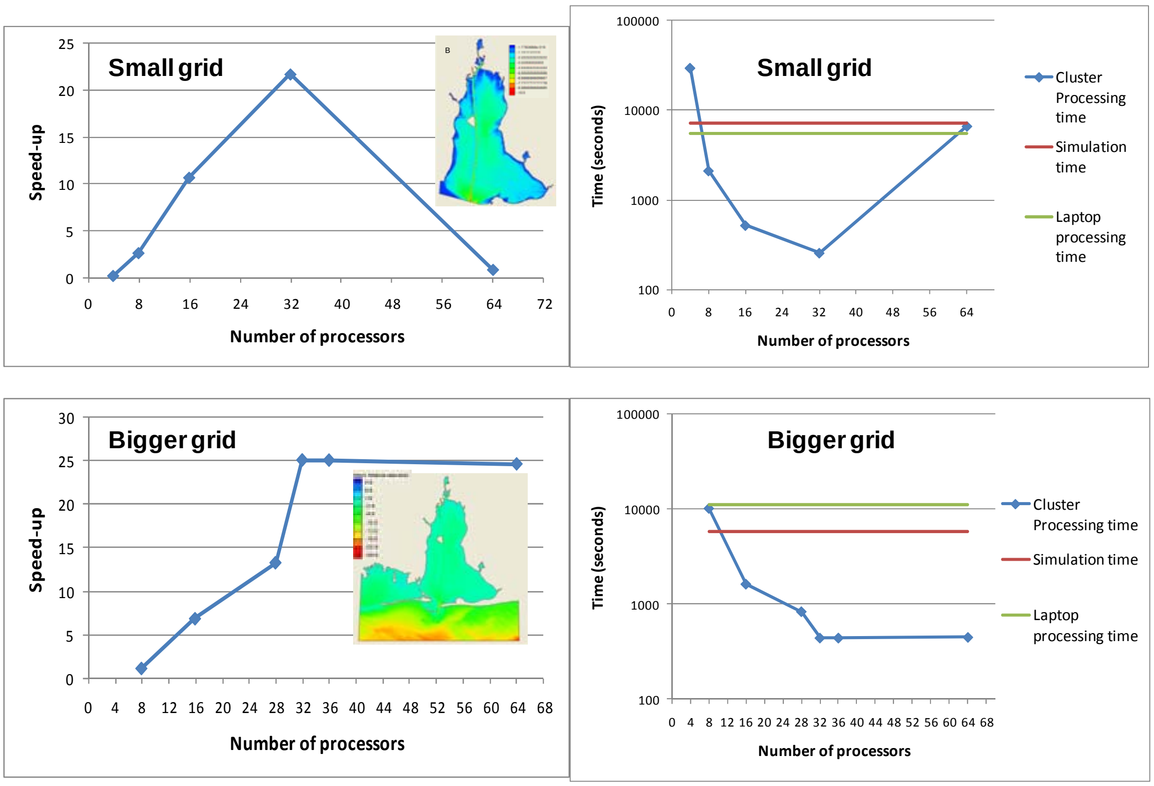


Figure 25. Speed up experiments for two ADH model applications for Mobile Bay. Thirty two (32) processors were determined to be the optimum number of processors for the model applications.

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 27. 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.

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 focused 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. The analysis provided two separate spatial information products (SIPs) in addition to the ones generated during the data processing which themselves provide information that can be used for future modeling efforts within the study area. Final SIPs represent the P-Erode (Figure 28a) and T-Erode (Figure 28b) with simple comparisons between each of the four sub basins and the entire Mobile Bay EDA (Table 3).

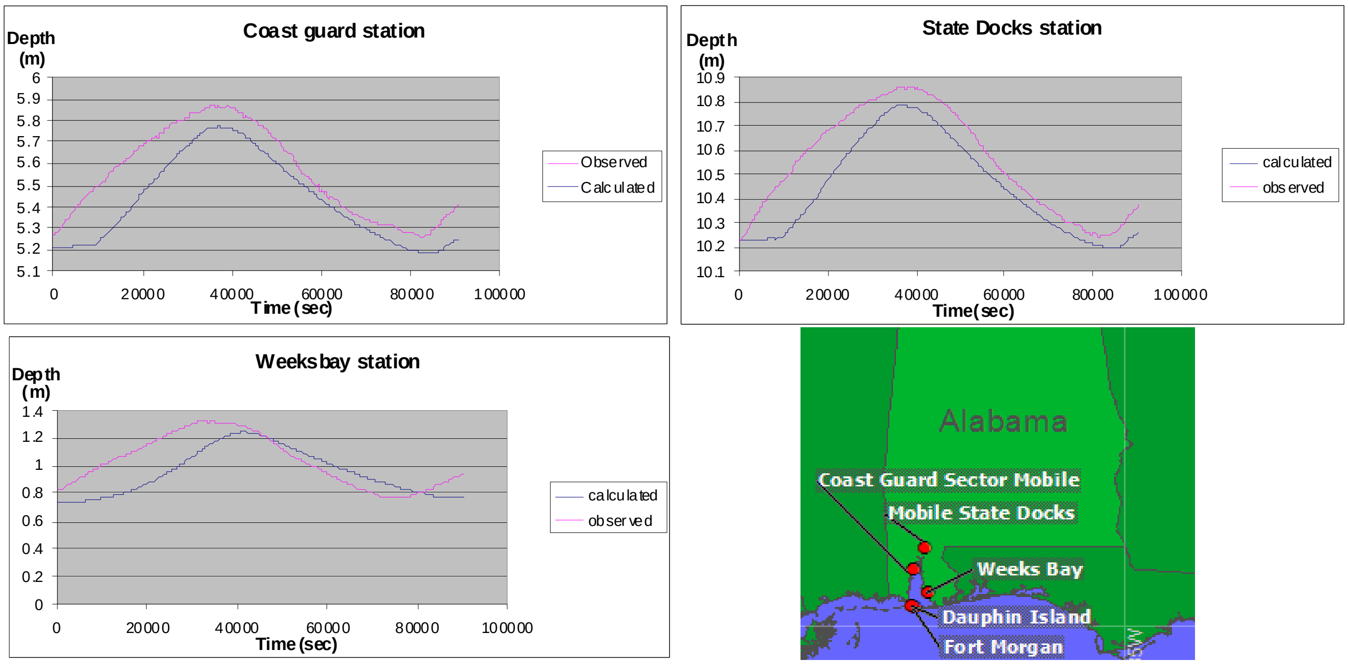


Figure 26. NOAA tidal data stations located within and around Mobile Bay (Dauphin Island, Weeks Bay, Coast Guard, and State Docks) were used to perform a preliminary adjustment. Measured and calculated water surface elevations were compared.

Table 3. Summary tables for P-Erode and T-Erode (total erodability) for the four sub-basins of the Mobile Bay EDA.

P-Erode Summary

Class	Lower Tombigbee		Lower Alabama		Mobile-Tensaw		Mobile Bay		Total	
1	0	0.00%	86	0.00%	100998	3.73%	109802	8.13%	**210886**	**1.66%**
2	1390174	29.99%	1539162	38.15%	1339655	49.50%	1101015	81.48%	**5370007**	**42.19%**
3	2716424	58.60%	1832276	45.41%	1103196	40.76%	133932	9.91%	**5785829**	**45.46%**
4	472534	10.19%	606468	15.03%	156988	5.80%	6440	0.48%	**1242430**	**9.76%**
5	56482	1.22%	56813	1.41%	5540	0.20%	4	0.00%	**118839**	**0.93%**

T-Erode Summary

Class	Lower Tombigbee		Lower Alabama		Mobile-Tensaw		Mobile Bay		Total	
1	0	0.00%	46	0.00%	0	0.00%	0	0.00%	**46**	**0.00%**
2	2712187	58.51%	2392547	59.30%	1061539	39.22%	478394	35.41%	**6644669**	**52.21%**
3	1827117	39.41%	1484680	36.80%	1564696	57.82%	627620	46.45%	**5504114**	**43.24%**
4	95484	2.06%	155289	3.85%	79514	2.94%	245089	18.14%	**575376**	**4.52%**
5	826	0.02%	2243	0.06%	628	0.02%	90	0.01%	**3787**	**0.03%**

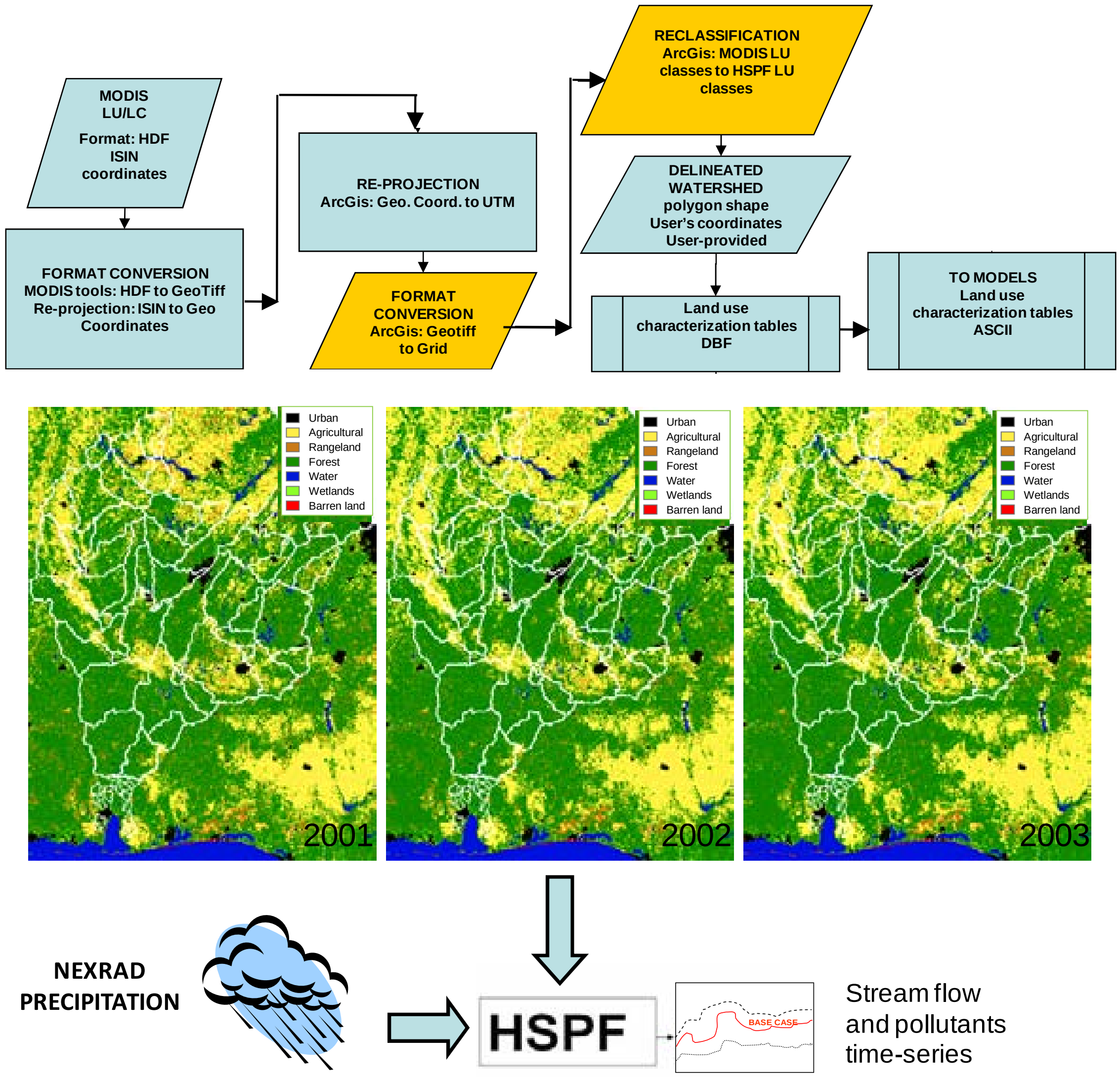


Figure 27. NASA MODIS land-use/land-cover datasets geo-processing for input into hydrological models of Mobile River watershed and Mobile Bay.

The Sulis, a computer-based water resources decision support toolkit, frame work was developed. The framework provides the foundation that will provide ready access to environmental and natural resources information in a useful form to better understand aquascapes and their processes. This allows for the evaluation of probable consequences of management decisions and natural change. Data that was gathered and assembled for the Mobile Basin is being transferred with the Sulis framework to stakeholders and users for preliminary interactions. The following figures provide examples of different platforms being utilized in the framework.

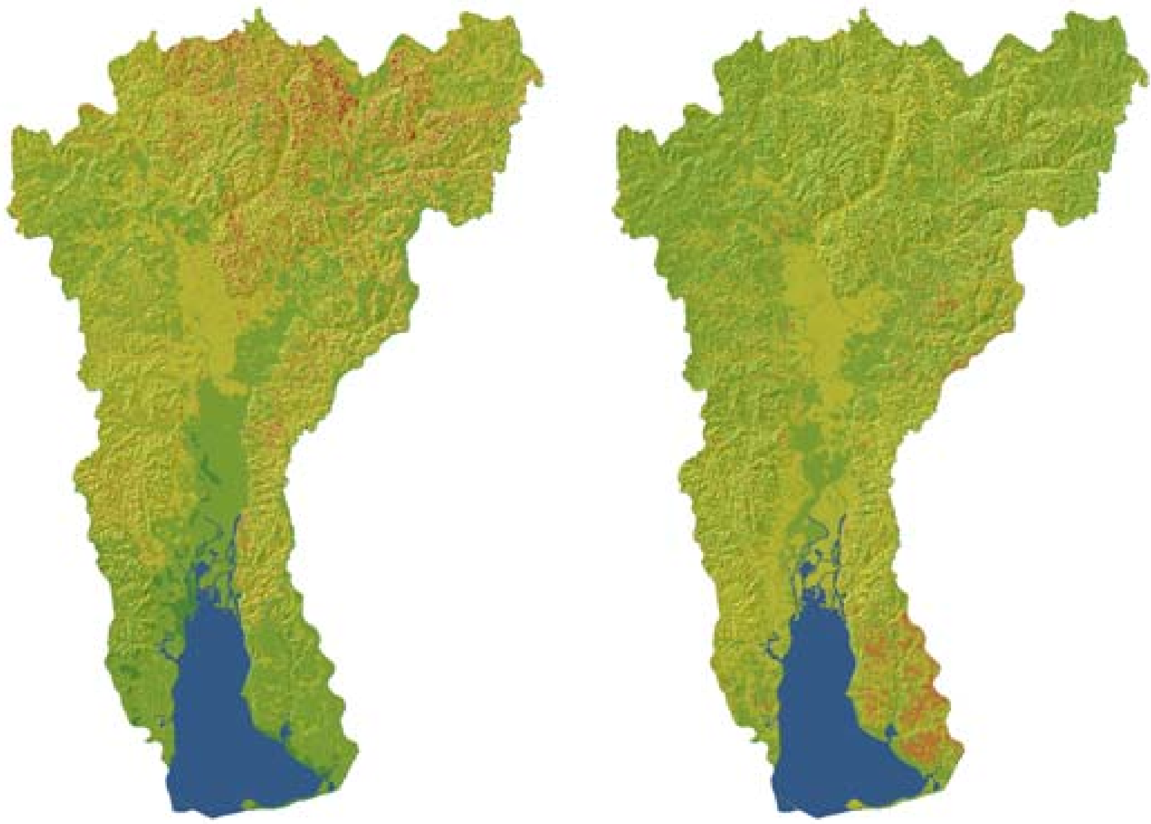


Figure 28. a) P-Erode (physical erodability) for the Mobile Bay EDA and b) T-Erode (total erodability) for the Mobile Bay EDA.

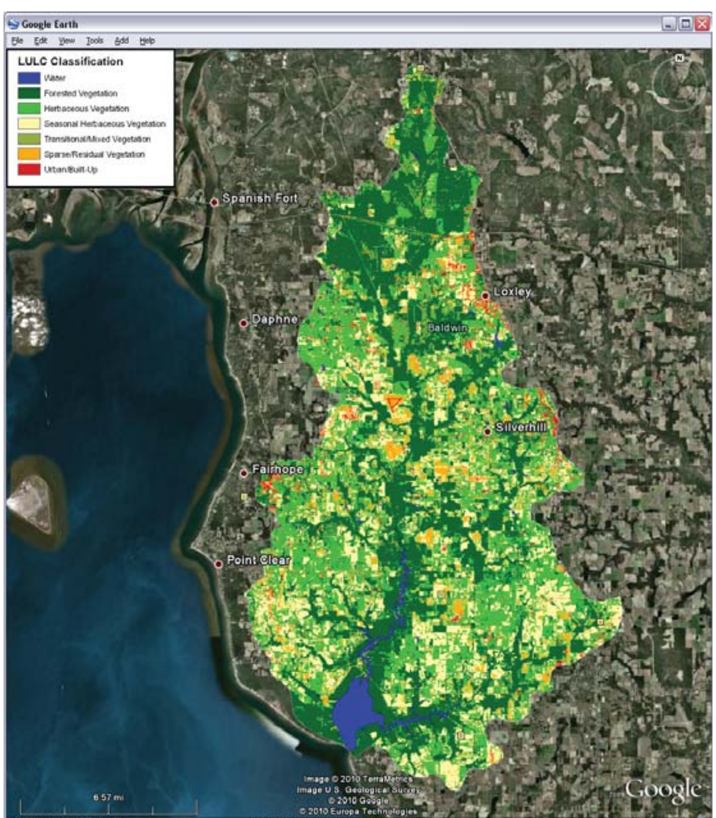


Figure 29. Google Earth packages for the Weeks Bay NERR allowing for the transfer of land use and land cover data.

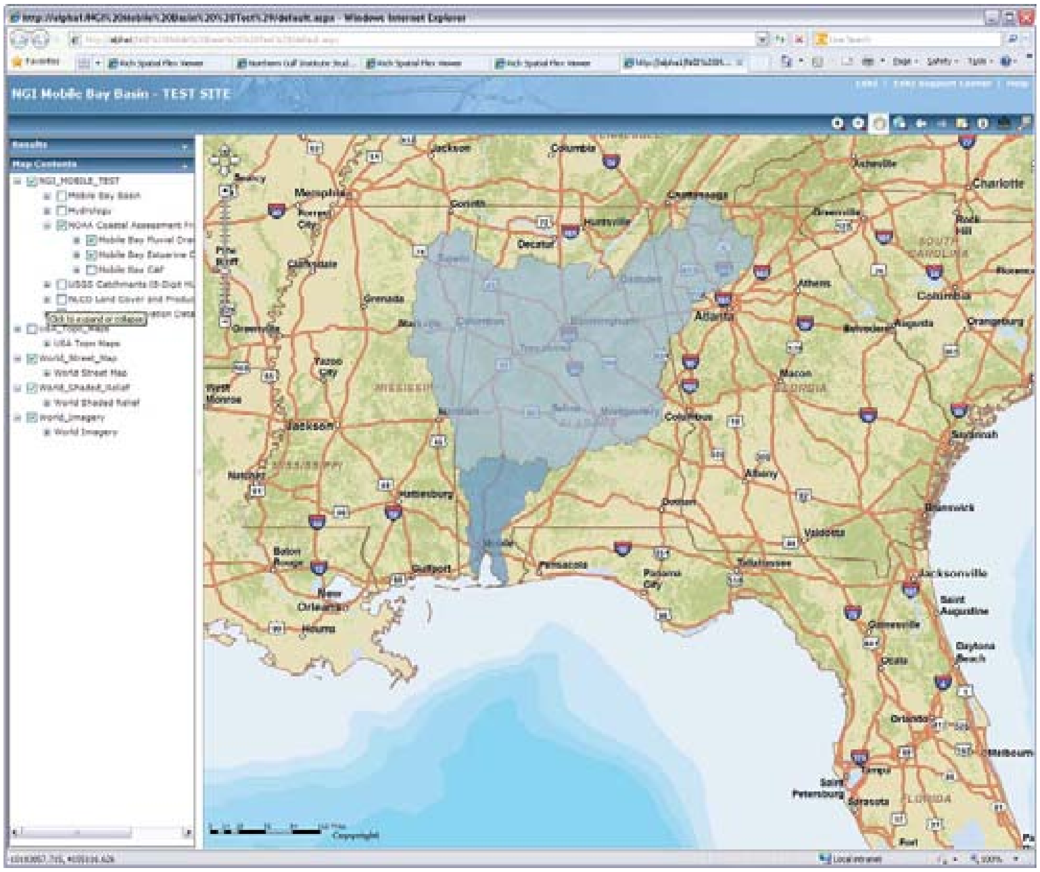


Figure 30. ArcServer application for the Mobile Bay basin allowing users to interact with a range of physical data. Including: elevation, land cover, hydrology, drainage basins, and products derived from these data.

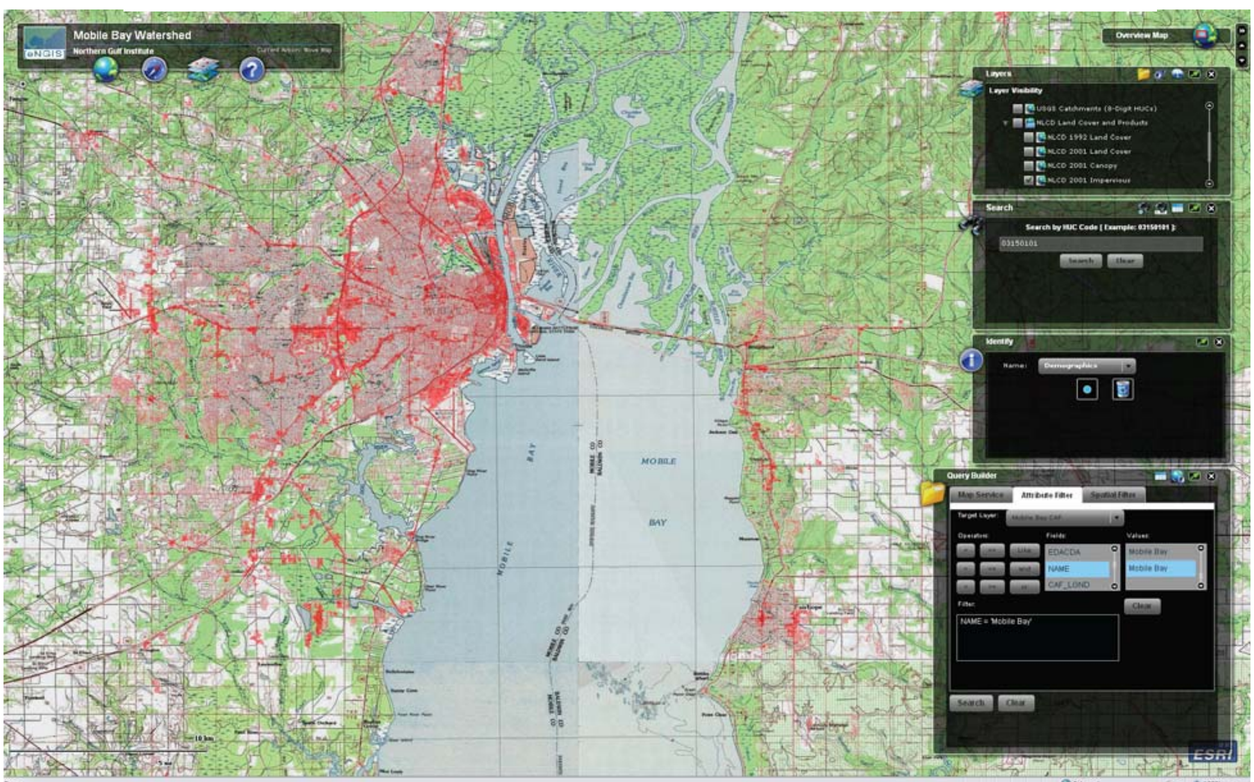


Figure 31. Web mapping application that allows users to query, search, and identify geospatial data. Developed in the Flex environment for a rich visual experience.

11. Outreach activities

General Description: Multiple meetings with basin and NOAA stakeholders

Type: Workshop

Date: 13 November 2008

Location: Weeks Bay National Estuarine Research Reserve

Description: NGI Research Activities and Efforts -WKBNERR. Presentation of NGI research activities associated with the Weeks Bay area.

Approximate Number of Participants: 12

Type: Workshop

Date: 19 June 2008

Location: Mississippi State University

Description: Surface-water Modeling System (SMS). Ms. B. P. Donnell and J. Pettway gave a hands-on workshop in sue of the SMS

Approximate Number of Participants: 10

Type: Speaker

Date: 13 February 2008

Location: Mississippi State University

Description: Seminar on 3D modeling of Mobile Bay. Dr. Kyeong Park of DISL spoke and met with researchers.

Approximate Number of Participants: 15

Type: Workshop

Date: 8 November 2007

Location: Mississippi State University

Description: e-Coastal, Enterprise GIS Training Workshop. Rose Dopsovic provided training for the ACOE enterprise system, e-Coastal

Approximate Number of Participants: 15

Type: Workshop

Date: 5-7 November 2007

Location: Dauphin Island Sea Lab

Description: Mobile Bay Collaboration Network Workshop. Presentations, descriptions, and discussions about current and planned research in the Mobile Bay study area.

Approximate Number of Participants: 30

Type: Speaker

Date: 20 August 2008

Location: Alabama Department of Environmental Management

Description: NGI Research Efforts and Activities in the Mobile Basin. Presentation and discussions on the research efforts of NGI in the Mobile Basin.

Approximate Number of Participants: 10

Type: Workshop

Date: 20-21 June 2007

Location: Dauphin Island Sea Lab

Description: Lower Mobile Basin Stakeholder Workshop. Workshop with Mobile Bay NEP, ADCNR Coastal Lands, and various other agencies on the research needs and collaborations in the lower Mobile Basin.

Approximate Number of Participants: 25

12. Peer Reviewed Articles

Alarcon, V. J., and McAnally, (2010). A Strategy for Estimating Nutrient Concentrations using Remote Sensing Datasets and Hydrological Modeling. International Journal of Agricultural and Environmental Information Systems (IJAEIS), Special Issue On: Analyzing, Modeling and Visualizing Spatial Environmental Data.(Accepted).

Alarcon, V. J., McAnally, W. H., Ervin, G. N., & Brooks, C. P. (2010). Using MODIS Land-Use/Land-Cover Data and Hydrological Modeling for Estimating Nutrient Concentrations. In Taniar, D.; Gervasi, O.; Murgante, B.; Pardede, E.; Apduhan, B.O. (Eds.), Computational Science and Its Applications. Berlin: Springer-Verlag Lecture Notes in Computer Science. 1(6016), 501-514.

Alarcon, V. J., McAnally, W. H., Diaz-Ramirez, J., Martin, J., & Cartwright, J. H. (2009). A Hydrological Model of the Mobile River Watershed. In G. Maroulis, T.E. Simos (Eds.), Computational Methods in Science and Engineering: Advances in Computational Science.. Melville, New York: American Institute of Physics. Volume 1148, 641-645.

Alarcon, V. J., McAnally, W. H., Wasson, L. L., Martin, J., & Cartwright, J. H. (2009). Using NEXRAD Precipitation Data for Enriching Hydrological and Hydrodynamic Models in the Northern Gulf of Mexico. Computational Methods in Science and Engineering: Advances in Computational Science

(Maroulis, G. and Simos, T. E., Eds.). Melville, New York: American Institute of Physics. Volume 1148, 646-650.

Aziz, W., Alarcon, V. J., McAnally, W. H., Martin, J., & Cartwright, J. H. (2009). An Application of the Mesh Generation and Refinement Tool to Mobile Bay, Alabama, USA. Computational Methods in Science and Engineering: Advances in Computational Science (Maroulis, G. and Simos, T. E., Eds.). Melville, New York: American Institute of Physics. Volume 1148, 651-656.

Alarcon, V. J. (2009). Computational Water Resources in Coastal Areas. Computational Methods in Science and Engineering: Advances in Computational Science (Maroulis, G. and Simos, T. E., Eds.). Melville, New York: American Institute of Physics. Volume 1148, 640-641.

Alarcon, V. J., McAnally, W. H., Wali, A., & Cartwright, J. H. (2009). A Hydrodynamic Model of Mobile Bay, Alabama. Proceedings WMSCI-09, (Callaos, N., Chu, H., Eshraghian, K., Lesso, W., and Zinn, C. D. Eds.). Orlando, Florida: IIIS. IV, 30-35.

13. Non-refereed articles and reports for this project

McAnally, W. H., Alarcon, V. J., Amburn, P., Baca, J. A., Ballweber, J. A., Cartwright, J. H., Ervin, G. N., Jackson, R. E., Martin, J., Ortega-Achury, S. L., Ramirez-Avila, J. J., & Wilkerson, G. W. (2009). White Paper: Holistic Water Resources Management, A Professional Education Plan. Mississippi State University: Northern Gulf Institute.

14. Conference presentations and poster presentations for this project

Alarcon , V. J., McAnally, W., Ervin, G., Brooks, C., (2010). Using MODIS Land-Use/Land-Cover Data and Hydrological Modeling for Estimating Nutrient Concentrations. The 2010 International Conference on Computational Science and Its Applications (ICCSA 2010), March 23-26, 2010, at Kyushu Sangyo University, Fukuoka, Japan.

Alarcon, V. J., McAnally, W. H., Cartwright, J. H., Jackson, R., (2010). Spatial Technology and High Performance Computing for Improving Prediction of Surface Water Quality: Project Overview. 2010 Northern Gulf Institute Annual Conference, May 18-20, 2010 Mobile, Alabama.

Alarcon, V. J., McAnally, W. H., Cartwright, J. H., Jackson, R., (2010). Poster: Water Resources Modeling in the Mobile River Watershed and Mobile Bay. 2010 Northern Gulf Institute Annual Conference, May 18-20, 2010 Mobile, Alabama.

Cartwright, J. H., Givens, W. McAnally, W. H., Alarcon, V. J., (2010). Poster: Digital Mapping Services: Is there an App for that?. 2010 Northern Gulf Institute Annual Conference, May 18-20, 2010 Mobile, Alabama.

McAnally, W. H., Cartwright, J. H., R. Jackson; J. Martin; J. Diaz-Ramirez., (2010). SULIS – A Tool for Healthy Watersheds, Healthy Oceans, Healthy Ecosystems. 2010 Northern Gulf Institute Annual Conference, May 18-20, 2010 Mobile, Alabama.

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.

Alarcon, V. J., (2009). Actividades de Modelaje y Simulación en Recursos Hídricos: Northern Gulf Institute (NGI) y GeoSystems Research Institute (GRI), Mississippi State University. Universidad Nacional de Salta, Civil Engineering Department. Salta, Argentina. December 30, 2009.

Alarcon, V. J., (2009). SC09 Workshop Project. Parallel Programming and Cluster Computing Workshop. University of Oklahoma, Norman, Oklahoma, August 9-15, 2009.

Alarcon, V. J., McAnally, W. H., Cartwright, J. H., (2009). Spatial Technology and High Performance Computing for Improving Prediction of Surface Water Quality (Project Overview). 2009 Northern Gulf Institute Conference. Mobile, Alabama, May 19-20, 2009.

Cartwright, J. H., McAnally, W. H., & Alarcon, V. J. (2009). Spatial Technologies for Watershed Erosion Analysis. *Northern Gulf Institute Annual Conference*. Mobile, AL.

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. [Presenter]

Cartwright, J. H., Aziz, W., Alarcon, V. J., McAnally, W. H., & Martin, J. (2008). Spatial Technology and High Performance Computing in Water Resources. *NGI Annual Conference*. Biloxi, MS.

15. Personnel from this project hired by NOAA during this reporting period:

None

16. NOAA Sponsor and NOAA office of primary technical contact for this project:

Julien Lartigue, NOAA Office of Oceanic and Atmospheric Research

PROJECT 06-MSU-06: VISUALIZATION TECHNIQUES FOR IMPROVING PUBLIC UNDERSTANDING OF CATASTROPHIC EVENTS

1. Project Leads:

Name	*Title*	*Affiliation*	*Email*
Robert Moorhead	Project lead	Mississippi State University	rjm@gri.msstate.edu
Song Zhang	Co-PI	Mississippi State University	szhang@gri.msstate.edu
Phil Amburn	Co-PI	Mississippi State University	amburn@gri.msstate.edu

2. All Non-Student Personnel funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Robert Moorhead	Professor	PhD	7%	No
Song Zhang	Professor	PhD	10%	No
Phil Amburn	Professor	PhD	20%	No
Derek Irby	Research Associate	BS	30%	No
Jean Mohammadi-Aragh	Research Associate	MS	30%	No

3. All Students funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Keqin Wu	MS	PhD	50	No
Jibonananda Sanyal	MS	PhD	50	No

4. Project Abstract:

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

5. Key Scientific Questions/Technical Issues:

The objectives of this project were:

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.

6. Collaborators/Partners:

Name of collaborating organization: HRD

Date collaborating established: Jul 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: We asked Joe Cione if he thought visualizing hurricane data in a large scale immersive environment would be useful. He said that sounded interesting. 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? None

Does partner provide non-monetary (in-kind) support? Yes, data code, advice, statement of needs, etc.

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? None

Does partner provide non-monetary (in-kind) support? None

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: UAS program

Date collaborating established: Jan 2009

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: We collaborated on a Yr4 NGI project proposal (Robbie Hood, NOAA lead) that was not funded. We have discussed further work.

7. Project Duration:

Feb 1, 2007 – May 15, 2010

8. Project Baselines:

Contributions to specific NOAA Goals/Objectives:

NOAA Goals 3 and 5. This research will serve society's needs for weather and water information and will advance NOAA's leadership in applied scientific research.

Contributions to regional problems and priorities:

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

How the project has narrowed gaps in regional knowledge, data, model performance, geographic coverage, etc.

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.

9. Objectives/Milestones accomplished in this period

During year 2, we 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 2009 NGI Annual Conference as well as at the IEEE EuroVis Conference.

We have used vGeo to visualize hurricane data. We have shown demos and provided images / videos to many people, including UAS 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 will appear this year. 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.

Since we learned in early 2009 that our focus in years 4-5 would be river flooding, we started working with the LMRFC to develop storm surge and river flooding visual analysis tools. Most of the work has been software infrastructure to date.

10. Significant research results, protocols developed, and research transitions

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.

11. Outreach activities

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.

Team members have consistently presented multiple papers and posters at NGI Annual Conference

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.

Talks at computer science department of Louisiana State University in May, 2007

We have visited LMRFC several times, demonstrating the software we have developed and discussing better ways to visualize their data

12. Peer Reviewed Articles

Jibonananda Sanyal, Song Zhang, Jamie Dyer, Andrew Mercer, Phil Amburn, and Robert Moorhead, “Noodles: An Interactive Tool for Visualization of Numerical Weather Model Ensemble Uncertainty,” *IEEE Transactions on Visualization and Computer Graphics* (Proceedings Visualization / Information Visualization 2010), Sept-Oct 2010 (to appear after minor revisions).

Shangshu Cai, Robert Moorhead, and Qian Du, “An Evaluation of Visualization Techniques for Remotely Sensed Hyperspectral Imagery,” in Optical Remote Sensing—Advances in Signal Processing and Exploitation Techniques, S. Prasad, L. M. Bruce, and J. Chanussot, Eds., chapter 6, Springer, 2010.

Keqin Wu, Zhanping Liu, Song Zhang, and Robert J. Moorhead II, “Topology-Aware Evenly-Spaced Streamline Placement,” *IEEE Transactions on Visualization and Computer Graphics,* (accepted, to appear).

Shangshu Cai, Qian Du, and Robert Moorhead, “Feature-Driven Multi-layer Visualization for Remotely Sensed Hyperspectral Imagery,” *IEEE Transactions on Geoscience and Remote Sensing,* (accepted, to appear).

13. Non-refereed articles and reports for this project

None

14. Conference presentations and poster presentations for this project

Derek Irby, Mahnas Mohammadi-Aragh, Robert Moorhead, and Phil Amburn, “Improving the Understanding of Hurricanes: Visualizing Storm Surge,” Proceedings of IEEE Oceans 2009, October 27-29, Biloxi, MS.

Elton Phil Amburn, Michael Berberich, Robert Moorhead, Jamie Dyer, and Manfred Brill, “Geospatial Visualization Using Hardware Accelerated Real-Time Volume Rendering,” Proceedings of IEEE Oceans 2009, October 27-29, Biloxi, MS.

Keqin Wu, Song Zhang, Phil Amburn, and Robert Moorhead, “Using FlowVis Techniques to Study Ocean Flow,” Proceedings of IEEE Oceans 2009, October 27-29, Biloxi, MS.

Keqin Wu, Song Zhang, Phil Amburn, and Robert Moorhead, “Using LIC-like FlowVis Technique to Visualize Hurricanes,” *IEEE Visualization Poster Compendium*, October 2009 (best poster award).

15. Personnel from this project hired by NOAA during this reporting period:

None

16. NOAA Sponsor and NOAA office of primary technical contact for this project:

Julien Lartigue, NOAA Office of Oceanic and Atmospheric Research

PROJECT 06-MSU-07: AN INFORMATION SEMANTIC APPROACH FOR RESOURCE AND KNOWLEDGE DISCOVERY IN AN INTEGRATED OCEAN OBSERVING SYSTEM

1. Project Leads:

Name	*Title*	*Affiliation*	*Email*
Roger L. King	Project Lead	Mississippi State University	rking@cavs.msstate.edu
Surya S. Durbha	Co-PI	Mississippi State University	suryad@cavs.msstate.edu

2. All Non-Student Personnel funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Roger L. King	PI	PhD	14%	No
Surya S. Durbha	Co-PI	PhD	50%	No

3. All Students funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Balakrishna Gokaraju	MS	PhD	100%	No
Santosh K. Akamanchi	BS	MS	100% thru Sep 2009	No
Shruthi Bheemireddy	BS	MS	100% thru Sep 2009	No
Rakesh Gourineni	BS	MS	50%	No

4. 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.

5. Key Scientific Questions/Technical Issues:

The IOOS consists of three subsystems

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

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

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

6. Collaborators/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.
- We are working on collaboration with NOAA Coastal Data Development Center (NCDDC) to transition research to operations. We anticipate interfacing with the 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 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 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 envisage augmenting the NOAA Ecosystems based management framework with Information Semantics. We are also working with European Space Agency (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.

7. Project Duration:

Jan 1, 2007 – Dec 31, 2010

8. Project Baselines:

NOAA Goals 1 and 5 is addressed by this project and other important NOAA goals that the IOOS data management & communications subsystem (DMAC) system related to ecosystem management 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.

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.

9. Objectives/Milestones accomplished in this period

Data and Application:

Updated data sets with data from additional buoys such as National Data Buoy center NDBC), Gulf of Maine Ocean Observing System (GoMoos), etc.,

Ontologies:

Ontologies development has been accomplished and has been used for integrating NDBC and GoMOOS data sources. This enabled interoperability between two different ocean observing systems. The querying of the disparate data sets has been demonstrated via advanced Resource Description Framework (RDF) based querying using SPARQL.

Completed the integration of the SPARQL query interface with the CosemWare application. .

Integrated RDF graph database that supports SPARQL queries.

Sensor Web:

Completed the development of the Sensor Observation Service (SOS) Database implementation.

The service discovery framework has been implemented using the OWL-S framework and has been demonstrated.

Implementation of the Sensor Alert Service (SAS) is still under progress.

Smart Mobile applications:

A *Tiny Coastal Sensor Web* implementation for Mobile devices has been accomplished using the Google's Android API for mobile platform. This enables the discovery of sensor observation services in catalogues and provides the ability to access the sensors observations via a smart phone (Figure 32).

We are in the final stages of completing the development of the CosemWare Portal.

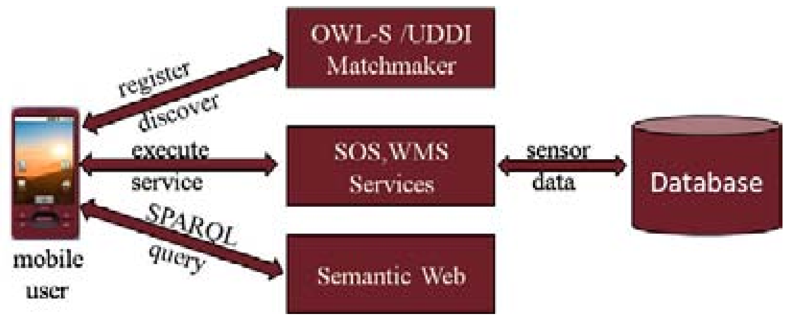


Figure 32. Once the user submits a request to query, then a list of concepts which define the inputs and outputs of the Web service pops up. The user has to select the concepts to be considered for matchmaking. Once the user selects the concepts, the matchmaker returns the appropriate services satisfying the user's requirements with a certain degree of match. After the appropriate service has been discovered the user is taken to the screen which facilitates the querying using the SOS from the smart mobile device. The results of the SOS query are displayed on a Google map (top left). The smart mobile client also enables to add other OGC web services such as Web Map service (WMS), Web Coverage Service (WCS) (bottom left).

10. Significant research results, protocols developed, and research transitions

A fully functional Sensor Observation Service (SOS) prototype is developed and deployed. It can handle several requests such as *GetCapabilities*, *DescribeSensor, GetObservation etc.* (Figure 33). Developed SensorML for selected (nearly 72) coastal sensors and observation processes with general models and XML encodings.

The developed Sensor Observation Service (SOS) supports various kinds of spatio-temporal querying such as:

A. *Spatial Subsetting*: The queries that are support this operation includes selecting a bounding box and retrieving all the sensors that measure a particular parameter. Overlap, containing, intersection are other spatial queries that can be executed on the sensors data.

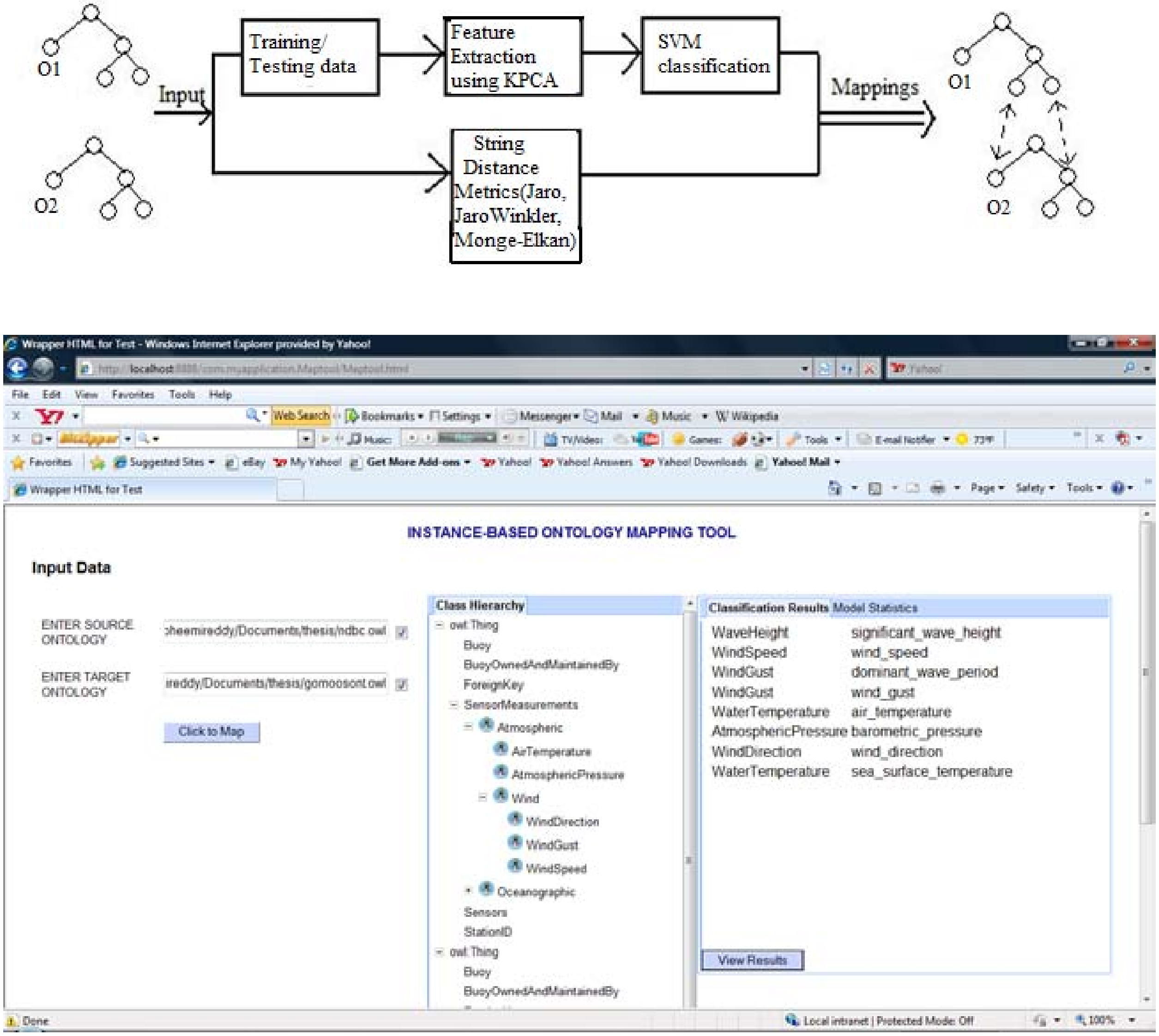


Figure 33. Schematic of the approach for ontology mapping and the COSEM-Map tool depicting the mapping pairs generated by executing the tool on source and target ontology.

B. *Temporal Subsetting and Filtering:* This represents the temporal subsets such as after a time instant, before time instant, during time instant, TEquals, past N sec/min/hrs/days. The sensors data can be requested for any time periods in the past (e.g. past 3 days). Also, the requests use the OGC Geography Markup Language (GML) to represent the temporal and spatial entities. SOS also supports filtering of the sensors data based on comparison operators such as Between, EqualTo, NotEqualTo, LessThan, GreaterThanEqualTo, etc.

A fully functional demonstration of Sensor Web prototype (CosemWare) was done on 06/17/09 to personnel from NOAA Coastal Data Development Center (NCDDC).

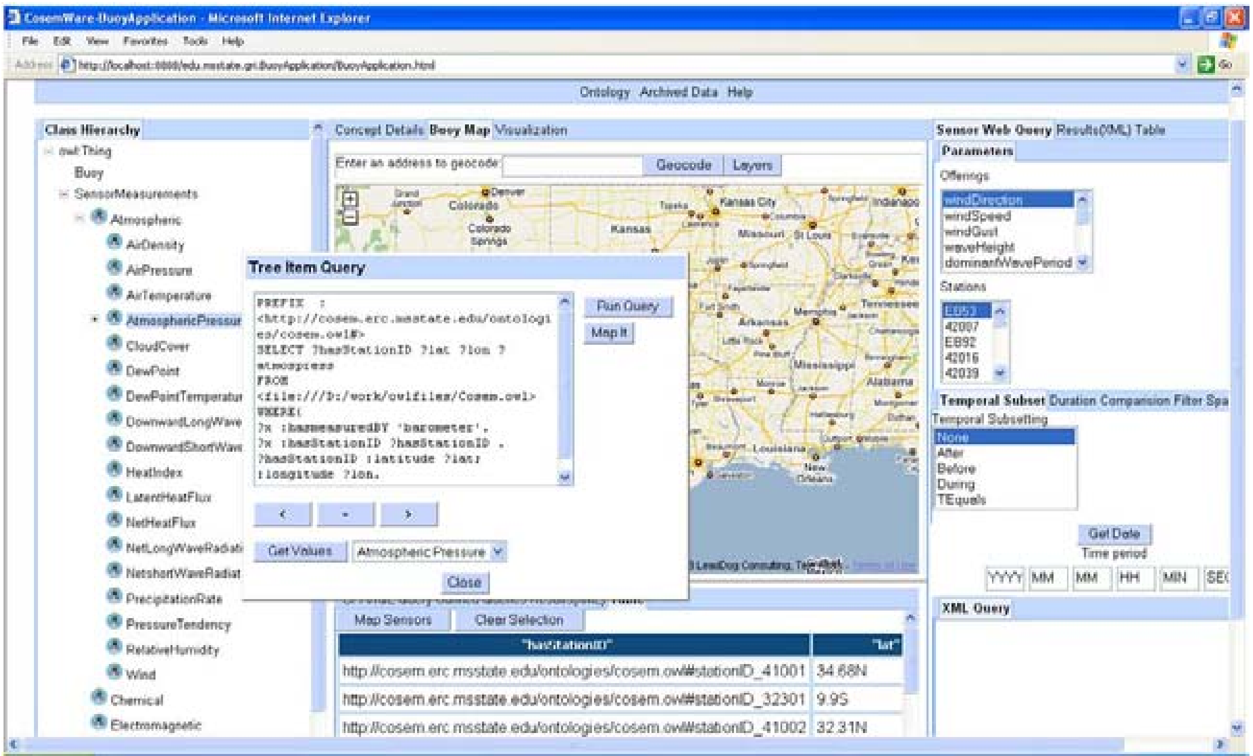


Figure 34. Example of a SPARQL Query (Scenario: “Find devices that can produce certain output variables”)

Knowledgebase has been developed by the instantiation of the ontological models with the data from Buoys. Querying based on SPARQLquery language has also been integrated in the CosemWare application. SPARQL is a query language for semantic web data sources. It is based on matching graph patterns. Graph patterns contain triple patterns. We implemented SPARQL querying (Figure 34) in the CosemWare application. We have integrated the querying using Jena and Joseki open source semantic web framework.

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.

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 are in the pipeline.

An ontology mapping was developed to enable interoperability between different Ocean observing data management systems. Ontology mapping can be defined as “for each entity in ontology O1 find a corresponding entity that shares the similar meaning in ontology O2”. The mapping between ontologies facilitates knowledge interchange, and thus establishes semantic interoperability between different information sources. Ontology mapping enables efficient semantic-based knowledge retrieval from diverse data sources through query processing. An Ontology Merging Tool to facilitate Interoperability between Coastal Sensor Networks using machine learning techniques was developed (Figure 32). The developed hybrid approach called COSEM-Map (Coastal Semantics Mapping) approach is based on the machine learning and name matching techniques. This algorithm takes two ontologies expressed in Ontology Web Language as input and generates the similar concepts from both the ontologies as output.

The focus is on assessing the closeness between the instances contained in each of the ontology concepts to determine the similarity of the concepts.

We developed a smart mobile device application that enables the registration and discovery of semantic web services based on a certain matching algorithm by enhancing the traditional web services registry. The registration and discovery process is based on the semantic matching instead of keyword searching as used in the traditional UDDI discovery mechanism. The vision is to develop an application framework using Android mobile platform to interact with the web services using the OWL-S/UDDI matchmaker. This framework was applied for registering, discovering, and executing services like Sensor Web Service, Geospatial Information Service, etc from mobile. Once the Sensor web service is discovered, the mobile user can query on the information collected from the coastal buoys stored in the database using SOS. The ability to search for coastal web services and query them through a mobile phone has been successfully implemented.

11. Outreach activities

Offered a full day tutorial on "recent advances in classification" (co-instructor), at the International Geoscience and Remote Sensing Symposium (IGARSS), 2009.

Organized and co-chaired an invited session on "Data Mining and Machine Learning for Remote Sensing" at IGARSS 09.

12. Peer Reviewed Articles

Durbha, S. S., King, R., & Younan, N. (Jan, 2010) "Wrapper-Based Feature Subset Selection for Rapid Image Information Mining", IEEE Geoscience and Remote Sensing Letters, (1), 43 – 47.

Shah, V.P.; Younan, N.H.; Durbha, S.S.; King, R.L, (Jan 2010), "Feature Identification via a Combined ICA–Wavelet Method for Image Information Mining", IEEE Geoscience and Remote Sensing Letters. (1), 18 – 22.

Durbha, S. S., King, R., Amanchi, S., Bheemireddy, S., & Younan, N, "Standards-Based Middleware and Tools for Coastal Sensor Web Applications", IEEE Journal of Selected Topics in Earth Observations and Remote Sensing (JSTARS)- Earth Observation Sensor Web Special Issue (Accepted)

Gokaraju, B., Durbha, S.S. King, R.L. Younan, N.H., "A machine learning based spatio-temporal data mining approach for detection of harmful algal blooms in the Gulf of Mexico," IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing(JSTARS), (under second revision).

13. Non-refereed articles and reports for this project

None

14. Conference presentations and poster presentations for this project

Gokaraju, B. Durbha, S.S. King, R.L. Younan, N.H., "An improved ensemble approach using neural network decision fusion for reduction of false alarm rate in harmful algal bloom detection from satellite data ," IEEE International Geoscience and Remote Sensing Symposium, Jul, 2010. IGARSS 2010, Hawaii, U.S.A.

Durbha, S. S., King, R., Amanchi, S., Bheemireddy, S., & Younan, N. H. (Dec 2009). Information Services and Middleware for the Coastal Web. Proceedings of the International Conference on Spatial and Spatiotemporal Data Mining (SSTDM), Miami, FL.

Gokaraju, B., Durbha, S. S., King, R., & Younan, N. H. (Jul 2009). Sensor Web and Data Mining Approaches for Harmful Algal Bloom Detection and Monitoring in the Gulf of Mexico Region. Proceedings of the IEEE International Geosciences and Remote Sensing Symposium, Cape Town, South Africa.

Bheemireddy, S., Durbha, S. S., King, R., Amanchi, S., & Younan, N. H. (Jul 2009). An Ontology Merging Tool to Facilitate Interoperability between Coastal Sensor Networks. Proceedings of the IEEE International Geosciences and Remote Sensing Symposium, Cape Town, South Africa.

Amanchi, S., Durbha, S. S., King, R., Bheemireddy, S., & Younan, N. H. (Jul 2009). Mobile Computing and Sensor Web Services for Coastal Buoys. Proceedings of the IEEE International Geosciences and Remote Sensing Symposium, Cape Town, South Africa.

15. Personnel from this project hired by NOAA during this reporting period:

None

16. NOAA Sponsor and NOAA office of primary technical contact for this project:

Julien Lartigue, NOAA Office of Oceanic and Atmospheric Research

PROJECT 06-MSU-08: NORTHERN GULF INSTITUTE OUTREACH EFFORTS

1. Project Leads:

Name	*Title*	*Affiliation*	*Email*
Jarryl Ritchie	PI	NGI Program Office	jritchie@ngi.msstate.edu

2. All Non-Student Personnel funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Jarryl Ritchie	PI	MA	50%	No
Maggie Dannreuther	Research Associate	MBA	100%	No

3. All Students funded by this project:

None

4. 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.

5. Key Scientific Questions/Technical Issues:

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.

6. Collaborators/Partners:

Name of collaborating organization: DISL and USM Education and Outreach Programs

Date collaborating established: Feb 2007

Does partner provide monetary support to project? Amount of support? None

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: NGI 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: October 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 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: NGI works with the National Estuarine Research Reserves of the northern Gulf on several efforts including outreach workshops and citizen scientist coordination. NERRS have been instrumental in helping NGI help NOAA extend the Phytoplankton Monitoring Network across the northern Gulf region.

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? None

Does partner provide non-monetary (in-kind) support? None

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: Phytoplankton Monitoring Network (PMN)

Date collaborating established: Jun 2007

Does partner provide monetary support to project? Amount of support? None

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 PMN to develop and maintain a group of program volunteers along the Gulf Coast. NGI helps to facilitate training opportunities and PMN provides the equipment and trainers.

7. Project Duration:

February 1, 2007 - February 30, 2010

8. Project Baselines:

Contributions to specific NOAA Goals/Objectives:

NOAA Goals 1, 2, 3 and 4. The NGI Outreach project develops materials explaining NGI research and results which will help improve ocean literacy. In addition, NGI conducts the internship program, employees students, supports workshops and participates in university career fairs in order to support the NOAA goal of workforce development.

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.

How the project has narrowed gaps in regional knowledge, data, model performance, geographic coverage, etc.

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

9. Objectives/Milestones accomplished in this period

Objective	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. 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 – reported under 09-NGI_MOD-20	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 – reported under 09-NGI_MOD-30	NGI completed administration of the 2009 internship programs, supporting 12 interns and developed the 2010 internship programs, currently in progress and supporting 13 interns.

10. Significant research results, protocols developed, and research transitions

None

11. Outreach activities

General Description:

Outreach is the central thrust of this activity intended to help build a citizenry informed of the natural and anthropogenic factors within the Northern Gulf ecosystem. Activities have included organizing and hosting 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.

Date: May 18-20, 2010

Location: Mobile, AL

Description: Annual science meeting for NGI with paper and poster presentations, keynote speakers, and networking

Approximate Number of Participants: 170

12. Peer Reviewed Articles

None

13. Non-refereed articles and reports for this project

Northern Gulf Institute September 2009. ***Northern Gulf Institute Science, Education, and Research Management Plan,*** Northern Gulf Institute, Mississippi State University, Mississippi State, MS.

Northern Gulf Institute July 2009. ***Northern Gulf Institute Cooperative Institute Progress Report: Reporting Period July 1, 2008 – June 30, 2009,*** Northern Gulf Institute, Mississippi State University, Mississippi State, MS.

14. Conference presentations and poster presentations for this project

Presented Paper ***NGI Education and Outreach Overview*** by T. Miller-Way, M. Dannreuther, Jarryl B. Ritchie, Suzanne Shean at NGI 2010 Annual Conference – Mobile, AL, May 18, 2010

Presented Paper ***NGI Education and Outreach: Enhance NGI's Impact through Communication, Education, and Collaboration*** by Jarryl B. Ritchie, T. Miller-Way, M. Dannreuther, M. Carron, J. Harding, J. Lartigue at AGU Ocean Sciences Meeting 2010 – Portland, OR, February 23, 2010

Presented Paper ***The Resilience Social Climate Survey (CoastalIQ) - Measuring Coastal Knowledge and Attitudes Toward Coastal Hazards, Storm Preparation, Evacuation Decisions, Resilience and Community*** at the 10th Annual Coastal Development Strategies Conference in Biloxi, MS, May 2009.

15. Personnel from this project hired by NOAA during this reporting period:

None

16. NOAA Sponsor and NOAA office of primary technical contact for this project:

Julien Lartigue, NOAA Office of Oceanic and Atmospheric Research

PROJECT 06-MSU-09: IMPROVING HURRICANE INTENSITY AND LANDFALL ESTIMATION WITH REFINED MODELING

1. Project Leads:

Name	*Title*	*Affiliation*	*Email*
Pat Fitzpatrick	PI	Mississippi State University	fitz@gri.msstate.edu

2. All Non-Student Personnel funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Pat Fitzpatrick	PI	PhD	42%	No
Chris Hill	Research Associate	MS	35%	No
Yee Lau	Research Associate	MS	34%	No
Sachin Bhate	Research Associate	BS	41%	No

3. All Students funded by this project:

None

4. 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.

5. Key Scientific Questions/Technical Issues:

Address the fundamental physics of storm surge, as well as the impact of levee configurations and the loss of wetlands resulting from hurricane events; develop a new Saffir-Simpson scale for storm surge based on bathymetry, storm size, storm speed, and intensity.

6. Collaborators/Partners:

Name of collaborating organization: NOAA's Meteorological Development Lab

Date collaborating established: Mar 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: They provided a grid which replaces the Mississippi River levee with its natural ridge.

7. Project Duration:

Feb 2007 – Jan 2010

8. Project Baselines:

Contributions to specific NOAA Goals/Objectives:

NOAA Goal 3. 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 and an important component of NOAA's future hurricane prediction system in which ADCIRC will be coupled to HWRF. Storm surge research has also been identified as a high priority action item in the National Science Foundation document *Hurricane Warning: The Critical Need for a National Hurricane Research Initiative.*

Contributions to regional problems and priorities:

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

How the project has narrowed gaps in regional knowledge, data, model performance, geographic coverage, etc.

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

9. Objectives/Milestones accomplished in this period

- Model estimates of surge reduction by wetlands has been computed.
- A revised Saffir Simpson scale based on tropical cyclone size, intensity, storm speed, and continental shelf slope/depth has been developed.
- A paper has been submitted to *National Hazards Earth Systems Science*.
- A preprint was published and results presented at several seminars and conferences.

10. Significant research results, protocols developed, and research 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.
- SLOSH suggests less overtopping (no overtopping) of parish levees if river levees did not exist. ADCIRC contradicts this result.
- The Louisiana levee system did not alter the surge impact on the Mississippi coast
- SLOSH and ADCIRC suggest 2 feet reduction in surge every 3 miles of wetlands (twice as much as other research suggests). But, near levees, where water becomes trapped, wetland erosion does not reduce surge, although it may arrive sooner without wetlands.
- A revised Saffir Simpson scale based on tropical cyclone size, intensity, storm speed, and continental shelf slope/depth has been developed. A scale for Integrated Kinetic Energy has been developed as well. Other storm surge relationships have been developed. An abstract is shown below:

> This paper investigates the contributions of maximum sustained 10-m winds ($V_{\max}$), storm size, translation speed, and bathymetry to storm surge using the ADvanced CIRCulation model. The key concept is that coastal regions be defined by "bathymetry zones" based on shallow water proximity and continental shelf length. Depending on intensity, peak surge differs by 4.5-7 m between shallow and deep bathymetries. Adjustments of 7-16% for hurricane size are required in most bathymetries, but modifications for translation speed (8-19%) are only needed in shallow bathymetries.
>
> The distance of 1.5-m and 3-m surge inundation from landfall for the onshore wind section is also computed. Shallow bathymetries experience significant inundation far from landfall. Surprisingly, inundation levels outside landfall regions differ little between Category 3 and 5 hurricanes and may be predictable in major hurricane events.
>
> Integrated Kinetic Energy (*IKE*) as a surge variable is also investigated. *IKE* alone does not correlate well to surge, but shows potential as $IKE^m \times V_{max}^n$ ($0.3 \le m \le 0.8$ and $1 \le n \le 2$) when partitioned by bathymetry zones.

11. Outreach activities

Fitzpatrick was interviewed by Channel 15 in Greenville, MS (WXVT) Friday, June 18. Topics include the upcoming hurricane season and the impact of a hurricane's interaction with the oil spill.

12. Peer Reviewed Articles

None

13. Non-refereed articles and reports for this project

Fitzpatrick, P. J., N. Tran, Y. Li, and C. M. Hill, 2009. A proposed new storm surge scale. Oceans '09 MTS/IEEE, Biloxi, MS, October 26-29.

14. Conference presentations and poster presentations for this project

Fitzpatrick, P. J., Y. Lau, Y. Li, N. Tran, and C. Hill, 2009. A proposed new storm surge scale. National Weather Service, June 29, Slidell, LA.

Fitzpatrick, P. J., Y. Lau, Y. Li, N. Tran, and C. Hill, 2009. A proposed new storm surge scale. Oceans '09 MTS/IEEE, October 27-29, Biloxi, MS.

Fitzpatrick, P. J., Y. Lau, W. A. Petersen, and C. D. Buckley, 2009. An analysis of storm surge attenuation using USGS, FEMA, and NASA data. NASA Applied Sciences Gulf Workshop, December 8-10, New Orleans, LA.

Fitzpatrick, P. J., and Y. Lau, 2010. Myths about the cause of Hurricane Katrina's storm surge. School of Science and Engineering, Spring Seminar Series, Tulane University, Feb. 26, New Orleans, LA, [invited]

Fitzpatrick, P. J., Y. Lau, C. M. Hill, T. V. Wamsley, B. Jelley, and E. Valenti, 2010. Myths about the cause of Hurricane Katrina's storm surge. 29th Conference on Hurricanes and Tropical Meteorology, May 10-14, Tuscon, AZ.

15. Personnel from this project hired by NOAA during this reporting period:

None

16. NOAA Sponsor and NOAA office of primary technical contact for this project:

Julien Lartigue, NOAA Office of Oceanic and Atmospheric Research

PROJECT 06-USM-01: MICROBIAL SOURCE TRACKING AND ITS APPLICATION TO THE NORTHERN GULF OF MEXICO

1. Project Leads:

Name	*Title*	*Affiliation*	*Email*
R.D. Ellender	PI	University of Southern Mississippi	rdellender@gmail.com
Shiao Wang	Co-PI	University of Southern Mississippi	Shaio.Wang@usm.edu

2. All Non-Student Personnel funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
R.D. Ellender	Senior Researcher	PhD	0	No
Shiao Wang	Senior Researcher	PhD	0	No

3. All Students funded by this project:

Name	*Category (i.e., highest degree already obtained: BS, MS, PhD)*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Chris Flood	BS	PhD	100%	No

4. Project Abstract:

The objective of this study was to determine if statistically valid correlations could be shown between enterococcal counts of water samples from creek and coastal sites and the presence of four molecular, library-independent markers that specify human and/or sewage pollution. One hundred ninety samples were collected between May 2009 and September 2009 from 14 coastal sampling sites. Samples were tested for the presence of enterococci, fecal coliforms and the presence of genetic markers for *Methanobrevibacter smithii, Bacteroides, Bacteroides thetaiotaomicron,* and *Fecalibacterium.* The presence of each individual human/sewage markers was not statistically dependent upon the presence of any other. Of the logistic regressions performed for all the organisms and sites, there were only 7 significant correlations. Human specific Bacteroides had a significant relationship for collection sites and enterococci counts. *B thetaiotaomicron* had a significant relationship for collection sites and fecal coliforms. *Fecalibacterium* had no site specific correlations but was positively correlated to enterococci counts and had a strong qualitative correlation to fecal coliform counts.

5. Key Scientific Questions/Technical Issues:

On the Mississippi coast, water quality is routinely tested by the enumeration of enterococci. Enterococci (EN) are associated with a wide variety of fecal inputs from humans, feral and domestic animals and storm waters, but the counts offer no information regarding the source(s) of pollution that can degrade beach water quality. This failure impedes the ability of regulatory agencies and managers to protect public health and remediate sources of pollution. Of the MST methods available, those that focus on the detection of a single gene or group of host specific genes have emerged as creditable measures for reasons of specificity, sensitivity economy, speed and transferability. *Bacteroides* was the first bacterial human marker to be used in source tracking applications. Later, additional microbial human markers were developed including *Bacteroides thetaiotaomicron Methanobrevibacter smithii,* human polyomavirus and *Faecalibacterium.* In this study, EN and FC counts and the presence or absence (P/A) of the bacterial (*Bacteroides*, Btim, and Fecali) and archaeal (*M. smithii)* markers were analyzed in identical samples from Mississippi coastal waters. Statistical analyses were conducted to determine the correlation between EN and FC levels and the P/A of each human marker at each sampling site and to examine whether nearshore beach sampling sites with tidal creek influx were significantly different from those sites with no associated creek.

6. Collaborators/Partners:

No collaboration has been established for this project.

7. Project Duration:

07/1/09 – 1/31/11 (no cost extension granted)

8. Project Baselines:

Contributions to specific NOAA Goals/Objectives:

NOAA and other federal agencies such as EPA continue to search for ways to noticeably demonstrate the level and type of animal pollution that enters marine waters, and to relate this level to the overall risk of water contact. This project is aligned with this objective in that it contributes data pertaining to the use of novel indicators of human pollution of coastal waters.

Contributions to regional problems and priorities: How is the project tied to regional issues and priorities? Identify priority stakeholders, e.g., Gulf of Mexico Alliance, specific user groups.

The project relates to regional issues in that Mississippi and the surrounding states have beaches which demonstrate fecal pollution in the form of enterococci or fecal coliforms. States have no means of determining the source(s) of the pollution or the animal or origin of the fecal material. Thus, this investigation shows how pollution can be identified and the source of the material as it enters the marine environment.

How the project has narrowed gaps in regional knowledge, data, model performance, geographic coverage, etc.

The methods described in this study as able to be used in any location in the USA; as the use of specific animal markers is verified and used to examine coastal waters, the animal of origin question will be answered and decisions can be made on specific remediation efforts.

9. Objectives/Milestones accomplished in this period

Sampling Sites: Six Mississippi Department of Environmental Quality (MDEQ) coastal beach sites were chosen for analysis based on the frequency of beach closure events. They included one site with a moderate number of beach closures (1-2 /yr) (7A: 30°20'485"N 89°09.621'W), and five with high numbers of beach closures (3-5 /yr) (9: 30°22.201'N 89°04.783'W), 10: 30°22.559'N 89°03.161'W), 10A: 30^{0}22'455"N 89^{0}02'763"W, 11: 30°22.938'N 89°01.578'W), and 12A: 30°23.586'N 88°56.291'W). Six tidal creek sites that flow into the Mississippi Sound affecting MDEQ sites 7A, 10 and 11, were also tested (7ACC: 30^{0}20'518"N 89^{0}9'256"W; 7ACT: 30^{0}20'337"N 89^{0}09'377"W; CC1: 30^{0}22'46.89"N 89^{0}03'22.00"W, CC2: 30^{0}22'40.88"N 89^{0}03'18.47"W; AOC: 30^{0}23'14.42"N 89^{0}01'08.25"W, and Condo: 30°23'1.55"N89° 1'30.44"W, respectively). The coastal stations represented here are the dominant beach recreational sites along the Mississippi coast.

Enterococcus Isolation / characterization: Enterococci were cultured and enumerated following the United States Environmental Protection Agency (USEPA) Standard Method 1600 (Messer and Dufour, 1998; USEPA, 2006). Briefly, water samples were diluted (10^{0}-10^{-}6), filtered through a 0.45 µm, 47 mm cellulose acetate membrane (Pall Corporation, Ann Arbor, MI), placed on 60 mm Petri dishes containing mEI agar (BD Bioscience, Sparks, MD), and incubated at $41^{o}C$ for 24 hours. Colonies (≥0.5 mm in diameter) characterized by blue halos on mEI were designated enterococci. Counts were expressed as CFU/100ml.

DNA extraction and PCR analysis: Sample volumes (500ml) were filtered through 3.0 µm and 0.45 µm cellulose acetate membranes (Pall Corporation, Ann Arbor, MI) and the 0.45 µm filter extracted using the PowerSoil™ DNA kit (MoBio Laboratories, Inc., Carlsbad, CA). DNA concentrations were measured in ng/µl using a Nanodrop™ ND-1000 spectrophotometer (Nanodrop Technologies, Wilmington, DE) and frozen ($-20^{0}C$) pending analysis. The *Methanobrevibacter smithii* (Mnif142f and 363r), the Bacteroides (HF183F and Bac708R), the *B. thetaiotamicrobium* (B.thetaF and B,thetaR) and the *Fecalibacteriium* (HFB-F3 and HFB-R5) primers were purchased from Integrated DNA Technologies, San Jose, CA.

Capillary Electrophoretic analysis: PCR products were analyzed using the microchip electrophoretic system (MCE-202 MultiNA™, Shimadzu Corporation Kyoto, Japan) per the manufacturer's specifications.

Statistics: Logistic regressions were performed using JMP 8 software.

10. Describe all significant research results, protocols developed, and research transitions.

Figure 35. Coastal bench sampling site

Forty percent (310/768) of the samples tested positive for the presence of at least one of the human markers. Fresh (creek) and salt (coastal) water sampling sites represented 66% and 34%, respectively, of those samples that showed the presence of a marker. Markers observed at coastal sites impacted by a creek had a 3.2 to 1 chance of being positive when compared to coastal sites not impacted by a creek. Of the 310 positive reactions, 45 (15%) occurred at creek site CC2 followed by 12% at site CC1. The creek sites impacting coastal site 7A were next highest at 9%. All other sites had % (+) values of <9%. The *Btim* marker was positive 100 times (32%) followed by *Bacteroides* at 25%, *Faecalifacterium* at 22% and *M. smithii* (21%).

Because the data was collected in a nominal and continuous manner, we chose logistic regressions to analyze both the parametric and nonparametric data collectively. Logistic regression models were constructed for each of the four organisms in question using the JMP 8 software package. For each regression the sites of interest were given the attribute of a random variable to avoid pseudo-replication and the enterococci and fecal coliform counts were designated as covariates. Both effect Wald tests and effect likelihood ratio tests were run but the P-values reported are from the more robust effect likelihood ratio tests. For all regressions the parameters were set as $\alpha = 0.05$, $N = 14$, and DF = 13 for individual sites, DF = 1 for enterococci and fecal coliform counts. The results for the *M. smithii* regression with the sites as a random attribute was $X^2 = 11.19$, P>0.59, and the covariate EN/100ml $X^2 = 2.51$, P>0.11. The $X^2 = 11.17$ for sites regressed with the covariate FC/100ml, $X^2 = 1.01$ and P>0.31. The results for human specific *Bacteroides* with sites (random) was $X^2 = 49.70$, P>0.00 and the EN/100ml covariate $X^2 = 5.00$ with P>0.026. For sites (random) the $X^2 = 45.80$ with P>0.00 and the FC/100ml covariate $X^2 = 3.40$ with P>0.065. The results for *B. thetaiotaomicron* with sites (random) was ChiSquare = 56.44 with P>0.00 and the EN/100ml covariate $X^2 = 2.29$ with P>0.12. For sites (random) the $X^2 = 58.25$ with P>0.00 and the FC/100ml covariate $X^2 = 7.28$ with P>0.0069. The results for

Fecalibacterium with sites (random) was X^2 = 6.98 with P>0.90 and the EN/100ml covariate X^2 = 4.27 with P>0.03. For sites (random) the X^2 = 5.14 with P>0.97 with the covariate FC/100ml X^2 = 3.81 with P>0.0508.

Figure 36. Coastal creek sampling site

11. Outreach activities

PIs participated in several conferences presenting the preliminary results of this project.

12. Peer Reviewed Articles:

None

13. Non-refereed articles and reports for this project

None

14. Conference presentations and poster presentations for this project

ASM May 2010 (San Digeo, CA): Using Human Markers to Monitor Fecal Pollution on the Mississippi Gulf Coast. C. Flood[A], J. Ufnar[B], S. Wang[A], M. Carr[A] and R.D. Ellender[A], [A]Department of Biological Sciences, University of Southern Mississippi, 118 College Dr., #5018, Hattiesburg, MS 39406, Center for Science Outreach, Vanderbilt University Medical Center, 806 Light Hall, Nashville, TN 37232-0670.

NGI May 2010 (Mobile, AL): Lack of correlation between enterococcal counts and the presence of human specific fecal markers in Mississippi creek and coastal waters. C. Flood[A], J. Ufnar[C], S. Wang[A], J. Johnson[B], M. Carr[A] and R. Ellender[A*] [A]Department of Biological Sciences, University of Southern Mississippi, 118 College Dr., #5018, Hattiesburg, MS 39406; [B]Center for Research Support, 118 College Drive #5116, University of Southern Mississippi, Hattiesburg, MS 39406; [C]Center for Science Outreach, Vanderbilt University Medical Center, 806 Light Hall, Nashville, TN 37232-067

Mississippi Water Resources Conference 2009 (Tunica, MS): Using human specific molecular markers to monitor water quality along the Mississippi gulf coast. Christopher Flood, Matt Carr, Shiao Wang, Carl Qualls. Department of Biological Sciences, University of Southern Mississippi, 118 College Dr., #5018, Hattiesburg, MS 39406

15. Personnel from this project hired by NOAA during this reporting period:

None

16. NOAA Sponsor and NOAA office of primary technical contact for this project:

Julien Lartigue, NOAA Office of Oceanic and Atmospheric Research

PROJECT 06-USM-03: MONITORING AND ASSESSMENT OF COASTAL AND MARINE ECOSYSTEMS IN THE NORTHERN GULF

1. Project Leads:

Name	*Title*	*Affiliation*	*Email*
Stephan Howden	Lead	USM	Stephan.howden@usm.edu
Charlotte Brunner	Co-I	USM	Charlotte.brunner@usm.edu
Kevin Dillon	Co-I	USM	Kevin.dillon@usm.edu
Steven Lohrenz	Co-I	USM	Steven.lohrenz@usm.edu
Donald Redalje	Co-I	USM	Donald.redalje@usm.edu
Alan Shiller	Co-I	USM	Alan.shiller@usm.edu
Kjell Gundersen	Co-I	USM	Kjell.gundersen@usm.edu

2. All Non-Student Personnel funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Stephan Howden	Lead	PhD	8.3	No
Charlotte Brunner	Co-I	PhD	4.2	No
Kevin Dillon	Co-I	PhD	4.2	No
Steven Lohrenz	Co-I	PhD	0	No
Donald Redalje	Co-I	PhD	8.3	No
Alan Shiller	Co-I	PhD	8.3	No
Kjell Gundersen	Co-I	PhD	8.3	No
Cai	Postdoc	PhD	3.3	No
Kevin Martin	Research Associate	MS	41.7	No
Meritt Tuel	Research Associate	MS	16.7	No

3. All Students funded by this project:

None

4. Project Abstract:

USM has worked 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 focused upon the Lower Pearl River (LPR) estuary and on a set of sampling stations from the Bay of Saint Louis (BSL) out into the Mississippi Sound (MSS) and offshore to the 20 m isobath in the Mississippi Bight (MSB). The furthest offshore station was located at a buoy mooring location of the Central Gulf of Mexico Ocean Observing System (CenGOOS) south of Horn Island. Buoys at this site have made continuous (1/2 hourly) measurements of water quality variables including salinity, temperature, chlorophyll fluorescence, and turbidity.

The LPR estuary has been shown to reflect the inputs of nutrients and organic materials into the MSS. 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 has been 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, have been assembled in a database and are available to researchers and environmental managers to aid in decision-making.

5. Key Scientific Questions/Technical Issues:

The key scientific questions addressed in this study include:

- What is the seasonal variability of key water quality parameters in the Lower Pearl River Estuary, Bay St. Louis, the western Mississippi Sound and western Mississippi Bight and what are the controlling factors?
    - What is the variability of nutrient speciation and concentration in each of these sub-regions?
    - What is the affect on phytoplankton communities of the low N:P ratios in the Mississippi Sound (this is being done in a collaborative effort led by Dr. Karen Orcutt of USM)?
    - What is the variability of trace metals in each of these subregions?
    - What is the variability of dissolved oxygen in each of these subregions?
- What is the extent of seasonal hypoxia in the western Mississippi Bight and what are the mechanisms controlling its development?
    - What is the seasonality and timing of the onset of hypoxia and what controls this timing?
    - What are the areal and volumetric extents of hypoxia?
    - What are the relative roles in hypoxia formation and maintenance of: vertical stratification due to seasonal heating, local/regional freshwater input, and upwelling/downwelling; nutrient inputs from local/regional rivers, benthic fluxes, and wetland degradation; and carbon dynamics in overlying surface waters?
- What are the effects on the ecosystem due to hypoxia events?
    - How are the species composition of benthic foraminifers in the MSB affected by changes in dissolved oxygen levels in bottom waters?
    - What is the effect of hypoxia events on the benthic macrofauna (this question has been addressed by Dr. Rakocinski in a collaborative project)?
- What are the carbon fluxes within the study region?
    - What is the seasonality of air-sea CO_2 fluxes (this is being addressed in a collaborative effort with NOAA scientists Drs. Rik Wanninkhof and Chris Sabine)?
    - How are these fluxes related to environmental conditions specifically physical properties of water, freshwater discharge, nutrient levels, algal biomass, and winds?
    - How good are satellite-based extrapolations of pCO_2 for the coastal region and can better regional extrapolation algorithms be developed for differing discharge and seasonal conditions?

6. Collaborators/Partners:

None

7. Project Duration:

Feb 2007 – July 2010

8. Project Baselines:

Contributions to specific NOAA Goals/Objectives:

NOAA Goals 1, 2 and 4. This project has many facets that contribute to NOAA's Mission to understand and predict changes in Earth's environment and conserve and manage coastal and marine resources to meet our Nation's economic, social, and environmental needs. The NOAA Goals addressed by the project are

- Ecosystems Mission Goal
  - By building a backbone monitoring system for the Mississippi Sound and Bight this project provided the information that is required to understand effects of fluvial inputs of freshwater, nutrients, and other constituents on the Mississippi Sound and western Mississippi Bight ecosystems.
  - Through this projects relationship with NCDDC it was involved with developing the data management system for biogeochemical data, which has not received as much attention as physical data within the IOOS.

- Climate Mission Goal
  - Through this projects relationship with the Central Gulf of Mexico Ocean Observing System, and hence the IOOS, it was involved with the development with the global observation and data management system.
  - Through this projects relationship with NCDDC it was involved with developing the data management system for biogeochemical data, which has not received as much attention as physical data within the IOOS.
- Commerce and Transportation Goal
  - The collaboration with the NGI project *Utility of Ionosphere and Troposphere Models for Extending the Range of High-Accuracy GPS* lead to enhanced offshore positioning that will address transportation directly through better navigation tools.

Contributions to regional problems and priorities:

Gulf of Mexico Alliance

The Governors' Action Plan (GAP) for Healthy and Resilient Coasts outlined six priority issues for states bordering the GoM: Water Quality, Wetland Restoration, Environmental Education, Characterization of Gulf Habitats, Reduction of Nutrient Inputs and Coastal Resiliency. The 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. Five of the six priorities of the Gulf of Mexico Alliance (GOMA) were addressed by this NGI project. A mapping of properties monitored to GOMA priorities is shown in Table 1.

Gulf of Mexico Ocean Observing System

In order to begin collecting the necessary information on the needs and requirements of stakeholders, the Gulf of Mexico Ocean Observing System (GCOOS) has held a series of stakeholder workshops as funding has permitted This NGI project addressed 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. This project addressed all three concerns.

Mississippi Department of Marine Resources

The Mississippi Department of Marine Resources was very concerned about the potential effects on the MSS when the Bonnet Carre (BCS) was opened on April 11, 2008. As a response to these concerns, an additional set of stations in the western MSS were sampled on a monthly basis for the remainder of the project.

How the project has narrowed gaps in regional knowledge, data, model performance, geographic coverage, etc.

The western MSB has been very much understudied compared with the Louisiana shelf, west of the Balize delta. Even though the freshwater and nutrient loading are smaller in the MSB, it has been determined that some of the same environmental problems occur, such as hypoxia.

Before this study the seasonality of nutrients and other water column parameters in the western MSB were not well known.

9. Objectives/Milestones accomplished in this period

- Have sampled along the NGI line on 25 months.
- Have sampled BCS line on 21 months.
- Have measured hypoxic bottom waters in each spring and summer season.
- In 2008 mapped the largest hypoxia event ever recorded in the MSB.
- Some rather startling dissolved oxygen profiles were measured on the June 17 2008 NGI cruise. Hypoxic bottom waters were measured from station 4 to station 8. At station 8 the hypoxic layer was over 5 m thick in a 20 m water column.
- Nutrient data have shown anomalous N:P ratios that certainly indicate an anthropogenic source of Phosphate into the MSS. These nutrient data contrast sharply with earlier data reported in Turner and Rabalais (1999) for the same region.
- In the LPR, monthly discrete water sampling was performed. Samples for nutrients, dissolved and particulate organic matter, and dissolved and colloidal metals were collected.

10. Significant research results, protocols developed, and research transitions

- Discovery of seasonal hypoxia in the western MSB after seasonal transition from horizontally to vertically stratified water column.
- Evidence that hypoxia in the region leads to nutrient flux out of the benthos, and enhanced surface productivity, which can lead to enhanced bottom hypoxia.
- Documentation of phosphate enhancement (N:P ratios < 1) in the MSS that was originally found in the 1970s, but did not appear in the later literature. These low ratios can be found offshore of the barrier islands with the ratio increasing with depth.

11. Outreach activities

None

12. Peer Reviewed Articles

None

13. Non-refereed articles and reports for this project

Zhou, Z. and Guo, L. 2010. Variations in composition and size of dissolved and colloidal organic matter in the Bay of Saint Louis estuary. Proceedings of 2010 Goldschmidt Conference in Knoxville, Tennessee, June 13-18, 2010, *Geochim. Cosmochim. Acta*, 74 (12A), suppl., A1231.

14. Conference presentations and poster presentations for this project

Boyette, A., D. Redalje, S. Lohrenz, S. Howden, K. Gundersen & 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, Biloxi, MS [POSTER]

Brunner, C., S. Howden, K. Gundersen, Mapping of Hypoxic Zone in the Mississippi Bight in the Summer of 2006, Session 194, 2008 Ocean Sciences Meeting, March 2-7, 2008, Orlando, FL.

Brunner, C., S. Howden & K. Gundersen (2008) Mapping of hypoxic zone in the Mississippi Bight in the summer of 2006, Ocean Sciences Meeting, Orlando, FL

Cai, Y., Guo, L., Wang, X., Mojzis, A. K., and Redalje, D.G. 2010. The source and distribution of dissolved and particulate organic matter in the Bay of St. Louis, Mississippi. The 2010 Ocean Science Meeting, February 22-26, 2010, Portland, OR, Abstract #: IT45B-04.

Dillon, K., S. Howden, K. Gundersen, K. Martin & C. Brunner (2008) Early Onset of Hypoxia in the Mississippi Bight. Mississippi-Alabama Bays and Bayous Symposium, Biloxi, MS [POSTER]

Dornback, M. Seasonal and Spatial Factors Contributing to Phytoplankton Biomass

Variability in the Western Mississippi Sound, NGI Annual Meeting 2010 Conference, Mobile, AL [Student Poster]

Gundersen, K., S.D. Howden & S.E. Lohrenz (2010) Hypoxia Monitoring on the Mississippi Gulf Coast. Workshop to Coordinate Gulf of Mexico Hypoxic Zone Research, February 17-18, 2010, Bay St. Louis, MS [TALK]

Gundersen, K. (2009) Centers for Ocean Sciences Education Excellence (COSEE) -Ocean Systems "Ocean-Climate Interactive". National Science Teachers Association (NSTA) Conference, New Orleans, LA [TALK]

Gundersen, K. (2009) Biology and the hypoxia. Hypoxia in the Mississippi Bight, Mississippi Department of Marine Resources, Biloxi, MS [TALK]

Gundersen, K., K. Orcutt & R. Powell (2008) A Carbon Based Assessment of New Production on the Louisiana Shelf and its Impact on the Seasonal Hypoxia in the Region, OCCC Workshop, Orlando, FL [POSTER]

Guo, L. and P. Lin. 2010. Variations in chemical and phase speciation of phosphorus during estuarine mixing in the Bay of Saint Louis. Presentation at the 2010 Northern Gulf Institute Annual Conference, May 18-20, 2010, Mobile, AL.

Guo, L. and Lin, P. 2010. Partitioning and transformation of phosphorus between dissolved, colloidal and particulate phases in the Bay of Saint Louis. Proceedings of 2010 Goldschmidt Conference in Knoxville, Tennessee, June 13-18, 2010, Geochim. Cosmochim. Acta, 74 (12A), suppl. A365.

Guo, L., Cai, Y., Lohrenz, S.E., You, C. and Cai, W.-J. 2010. Radiocarbon composition and fluxes of dissolved inorganic carbon from the lower Mississippi River. Western Pacific Geophysics Meeting, June 22-25, 2010, Taipei, Taiwan.

Howden, S., C. Brunner, K. Dillon, K. Gundersen, L. Guo, S. Lohrenz, C. Rakocinski, D. Redalje, A. Shiller, K. martin, A. Mojzis & Y. Cai (2010) Monitoring and Assessment of Coastal and Marine Ecosystems in the Northern Gulf. Northern Gulf Institute Annual Conference, May 18-20, 2010, Mobile, AL [TALK]

Howden, S.D., C. Brunner, S.E. Lohrenz, L. Guo, D.G. Redalje, A.M. Shiller, K.M. Martin, K. Gundersen, M.-J. Shim & A. Mojzis (2009) Monitoring and Assessment of Coastal and Marine Ecosystems in the Northern Gulf: USM-03. Northern Gulf Institute (NGI) Annual Conference, Mobile, AL [TALK]

Howden, S.D., C. Brunner, S. Lohrenz, R. Redalje, A. Shiller & K. Gundersen (2008) Monitoring and Assessment of Coastal and Marine Ecosystems in the Northern Gulf, Biloxi, MS [POSTER]

Guinasso, N. L., L. C. Bender, S. D. Howden, J. N. Walpert, Wave Heights from a 3-m Discus Buoy in the Mississippi Sound during Hurricane Katrina, Session 151, 2008 Ocean Sciences Meeting, March 2-7, 2008, Orlando, FL.

Howden, S. D., C. Brunner, S. Lohrenz, D. Redalje, A. Shiller, and K. Gundersen. Monitoring and Assessment of Coastal and Marine Ecosystems in the Northern Gulf of Mexico, NGI Annual Meeting, 13-14 May, 2008, Biloxi, MS.

Howden, S. D., V. L. Asper, D. W. Dodd, S. E. Lohrenz, D. Roman, L. Bender, J. Walpert, and C.-A. Blain. Hurricane Katrina Waves and Storm Surge Observations by the Central Gulf of Mexico Ocean Observing System, Session 151, 2008 Ocean Sciences Meeting, March 2-7, 2008, Orlando, FL.

Howden, S. D., and C. Brunner. Detection of Hypoxic Conditions in the Mississippi Bight in the Summer of 2006, Mississippi Academy of Sciences, Abstract Issue of the Journal of the Mississippi Academy of Sciences, p 116, 2007.

Lin,P. and Guo, L. 2010. Dynamics of phosphorus in the Bay of Saint Louis estuary. Mississippi Academy of Sciences Annual Meeting, February 10-12, 2010, Hattiesburg, MS.

Huang, H., 2009. Copper (Cu) speciation within waters of the Yukon River Basin (Alaska) and the Lower Pearl River and its floodplain (Mississippi-Louisiana).‰ M.S. Thesis, The University of Southern Mississippi, Department of Marine Science.

Lohrenz, S., C. Brunner, S. Howden, D. Redalje, and A. Shiller. Monitoring and Assessment of Coastal and Marine Ecosystems in the Northern Gulf of Mexico, NGI Annual Meeting, 16-18 May, 2007, Biloxi, MS.

Lovko, V. J., H. A. Bowers, A. R. Place, S. E. Lohrenz, (2010). Characterization and Bloom-Forming Potential of the Toxic, Fish-Killing dinoflagellate Karlodinium veneficum in the Northern Gulf of Mexico, NGI Annual Meeting 2010 Conference, Mobile, AL.

Mitra, K., Zhou, Z. and Guo, L. (2010). Distributions of carbohydrates between dissolved and particulate phases during estuarine mixing in the Mississippi River plume. Presentation at the 2010 Northern Gulf Institute Annual Conference, May 18-20, 2010, Mobile, AL.

Redalje, D., S.E. Lohrenz, S.D. Howden, K. Gundersen, K. Martin, A. Mojzis, M. Shim (2010) The relationship between Chlorophyll, Dissolved Inorganic Nitrogen and Phosphate Concentrations in Northern Gulf of Mexico Waters. Northern Gulf Institute Annual Conference, May 18-20, 2010, Mobile, AL [POSTER]

Wells, Tami, Sharon Walker, Stephan Howden and Marcus Jarrett, The Role of Ocean Observing Systems in K-12 Education: Explaining the Concepts, Developing the Curricula and Applying the Technology, Abstract Issue of the Mississippi Academy of Sciences, p 148, 2007.

Williams, Kyle, Tami Wells, Stephan Howden, Conrad Johnson, and Sharon Walker, Central Gulf of Mexico Ocean Observing Systems (CenGOOS) K-12 Program Development, Abstract Issue of the Mississippi Academy of Sciences, p 146, 2007.

Zhou, Z. and Guo, L. 2010. Variations in optical properties of dissolved organic matter along a salinity gradient in the Bay of St. Louis estuary. Presentation at the 2010 Northern Gulf Institute Annual Conference, May 18-20, 2010, Mobile, AL.

15. Personnel from this project hired by NOAA during this reporting period:

None

16. NOAA Sponsor and NOAA office of primary technical contact for this project:

Julien Lartigue, NOAA Office of Oceanic and Atmospheric Research

PROJECT 06-USM-04: INTERACTION BETWEEN OFF-SHORE CIRCULATION AND NEARSHORE PROCESSES DURING EXTREME WEATHER EVENTS

1. Project Leads:

Name	*Title*	*Affiliation*	*Email*
Vladimir Kamenkovich,	Co-PI	University of Southern Mississippi	vladimir.kamenkovich@usm.edu
Dmitri Nechaev,	Co-PI	University of Southern Mississippi	dmitri.nechaev@usm.edu

2. All Non-Student Personnel funded by this project:

None

3. All Students funded by this project:

None

4. 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 wave-currents 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.

5. Key Scientific Questions/Technical Issues:

The major goal of the research is to study the interaction between the near-shore and off-shore processes during extreme weather events by using numerical modeling. The research is based on the Princeton Ocean Model and takes into account the recently suggested approaches to describing wave-currents interaction and the land-sea boundary motion.

Short term objectives: To analyze the effects of moving sea-land boundary and current-wave interaction on storm surges in the near-shore region

Long-term objectives: To advance our understanding of the dynamical links between coastal circulation and near-shore processes during extreme weather conditions to improve modeling and monitoring of the coastal circulation. More precisely, to develop special algorithms that will allow us to predict water level variations and water quality, debris and pollutant transports, to estimate effects of coastal restoration activities on sediment transport and to assess other environmental and economical impact of severe weather events. By these efforts we plan to contribute to the establishment of regional modeling systems off the Mississippi, Alabama and western Florida coasts and the integrated National Backbone for the northern Gulf.

6. Collaborators/Partners:

Name of collaborating organization: Naval Research Laboratory

Date collaborating established: Jan 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: Comparison of the POM wave model results with SWAN wave model.

Name of collaborating organization: Naval Oceanographic Office

Date collaborating established: Sep 2006

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: NGI provides educational services related to numerical modeling of coastal circulation and wave dynamics, NAVOCEANO provides some observational data.

Name of collaborating organization: Florida State University COAPS

Date collaborating established: Feb 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: 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.

Name of collaborating organization: University of Miami RSMAS

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: We are planning to exchange modeling results when RSMAS 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.

7. Project Duration:

Dec 2006 – Dec 2009

8. Project Baselines:

Contributions to specific NOAA Goals/Objectives:

NOAA Goal 3. The project supports NOAA's mission to improve capabilities for monitoring, assessment and prediction of severe weather events in the near-shore region.

Contributions to regional problems and priorities:

The project is aimed at the establishment of regional modeling systems off the Mississippi, Alabama and western Florida coasts and the integrated National Backbone for the northern Gulf.

How the project has narrowed gaps in regional knowledge, data, model performance, geographic coverage, etc.

The analysis of the effects of moving sea-land boundary and current-wave interaction on storm surges in the near-shore region.

9. Objectives/Milestones accomplished in this period

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 analyzed for the model configuration including tides and islands simulating Mississippi Bight.

An algorithm allowing to model effects of the wave-current interactions under strong wind action. **Done:** the wave model algorithm was tested and compared against the SWAN wave model. Comparison showed quantitative agreement between the models, while the POM wave model is approximately 10 times more efficient for the considered problem.

Analysis of available observations required for setting up the experiments to study the effects of extreme weather events on off-shore and near-shore circulations. **Done.**

Project report, presentations at CI workshops and scientific meetings, and submission of manuscripts for peer-reviewed journal articles. **Done.**

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**.

10. Significant research results, protocols developed, and research transitions

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 37.

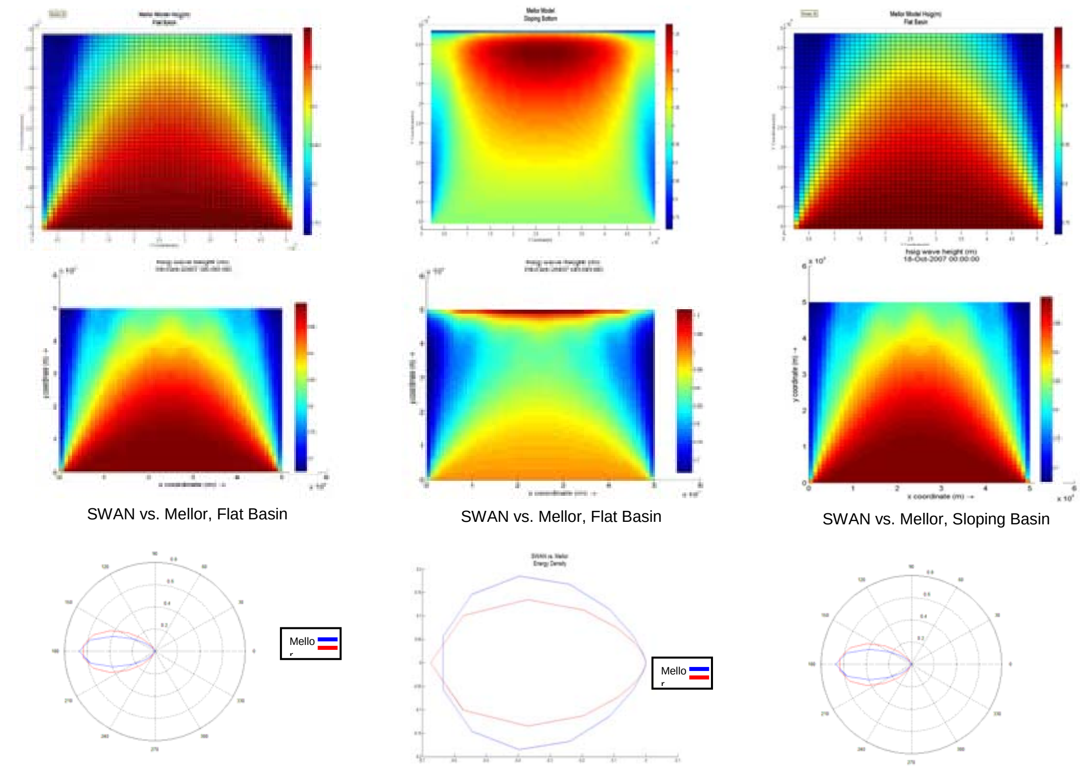


Figure 37. Significant wave hight (upper row – POM results, middle row – SWAN results) and directional wave energy spectra (lower row) in SWAN (blue line) and POM (red line) wave models for configurations with flat (left and right) and sloped bottom (middle column).

Figure 37 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.

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.

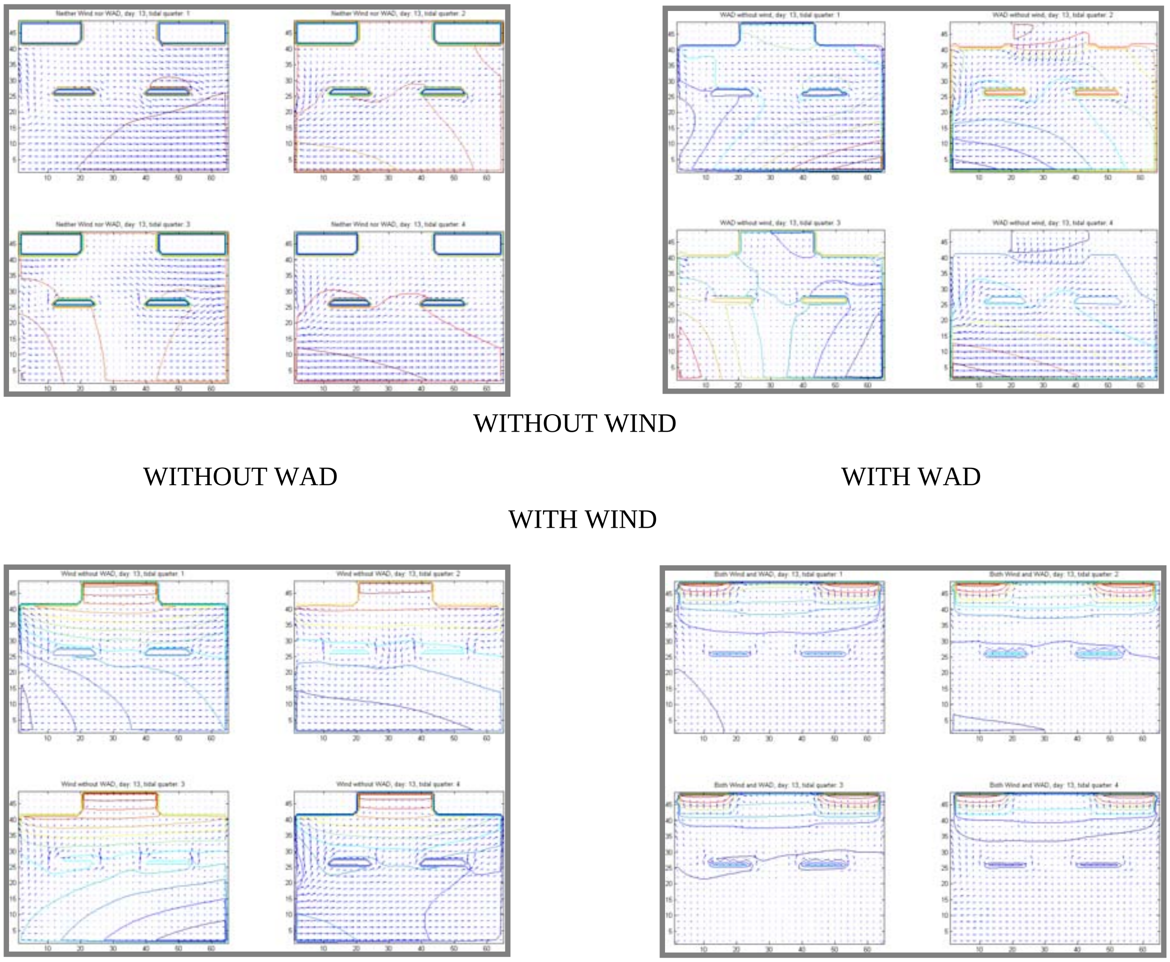


Figure 38. Sea surface elevation and current velocity vectors for four phases of the diurnal tide. Left panels show the circulation patterns with fixed sea/land boundary, right panels - with moving sea/land boundary. Upper panels demonstrate the effect of moving sea/land boundary on the distribution of tides. In lower panels the effect of wind surge on shelf circulation is also considered.

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 38. 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.

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.

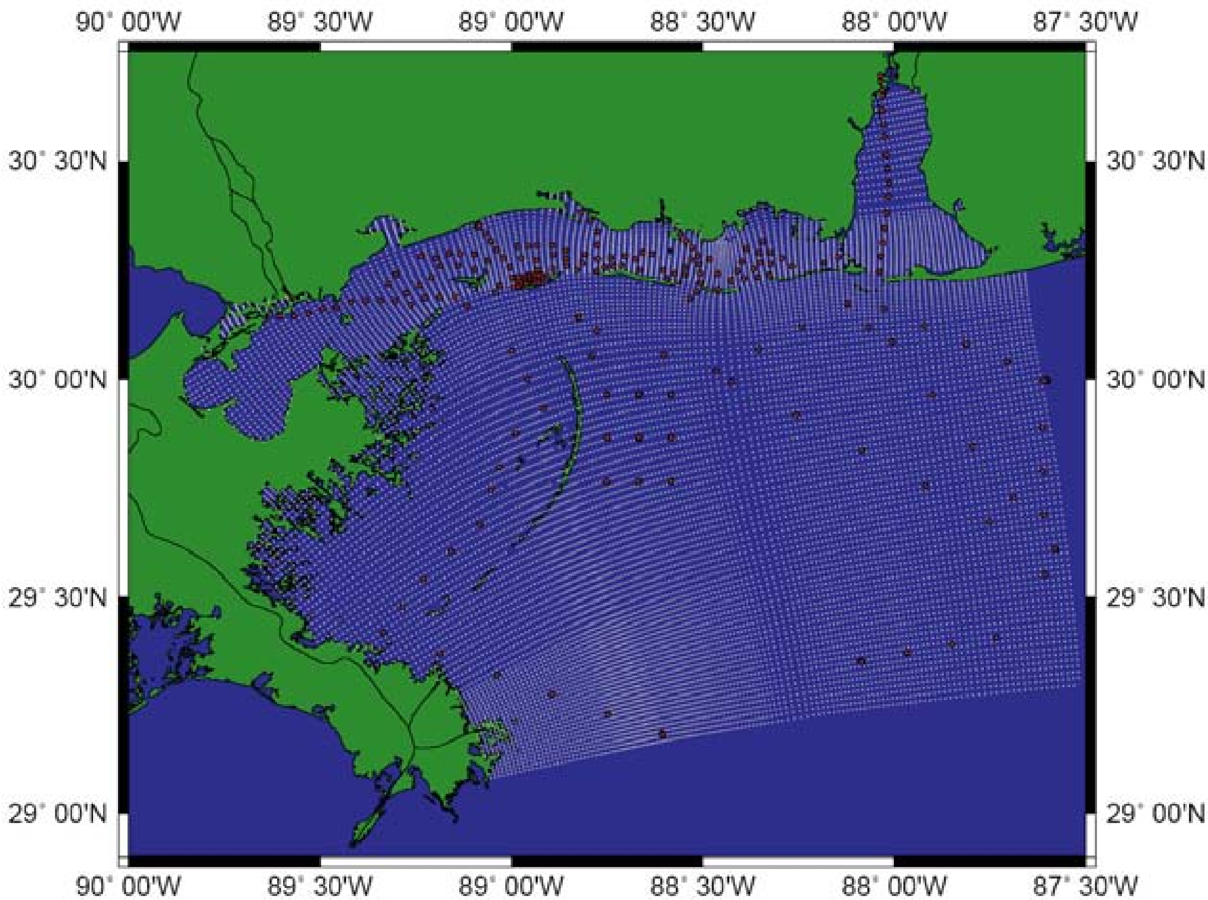


Figure 39. Configuration of the realistic model domain. Dots show locations of the CTD stations used to verify NGLI model.

11. Outreach activities

We disseminated objectives of the study and the preliminary research results on the Invited Professional Seminar: Kamenkovich, V., D. Nechaev: On the time-splitting scheme used in the Princeton Ocean Model. Seminar of the Mathematical Department of the USM, Hattiesburg, MS, October 26, 2007. The research results were discussed and presented to leading scientists in the area (George Mellor, Mike Brooking, Jay Veeramony, Villy Kourafalou and others).

12. 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.

13. Non-refereed articles and reports for this project

J. Wallmark, V. Kamenkovich, D. Nechaev, Simulating onshore saline transport during hurricane Katrina. *The Journal of the Mississippi Academy of Sciences* (ISSN 0076-9436), Vol 53, No. 1, 89-90, January 2008.

14. Conference presentations and poster presentations for this project

V. Kamenkovich, D. Nechaev, J. Wallmark, Interaction between off-shore circulation and near-shore processes during extreme weather events, 2007 Annual Northern Gulf Institute Conference, Biloxi, MS, May 2007. Poster.

V. Kamenkovich, D. Nechaev, J. Wallmark, Interaction between off-shore circulation and near-shore processes during extreme weather events, 2008 Annual Northern Gulf Institute Conference, Biloxi, MS, May 2008. Poster.

J. Wallmark, V. Kamenkovich, D. Nechaev, Simulating onshore saline transport during hurricane Katrina. MAS, Seventy-second Annual Meeting, February 20-22, 2008.

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.

15. Personnel from this project hired by NOAA during this reporting period:

None

16. NOAA Sponsor and NOAA office of primary technical contact for this project:

Julien Lartigue, NOAA Office of Oceanic and Atmospheric Research

PROJECT 06-USM-05: SATELLITE AND IN SITU OPTICAL ASSESSMENT OF ALGAL BLOOM EVENTS IN THE NORTHERN GULF OF MEXICO

1. Project Leads:

Name	*Title*	*Affiliation*	*Email*
Steven E. Lohrenz	Project Lead	University of Southern Mississippi	Steven.Lohrenz@usm.edu
Vernon Asper	Co-PI	University of Southern Mississippi	Vernon.Asper@usm.edu
Gregory Carter	Co-PI	University of Southern Mississippi	Greg.Carter@usm.edu

2. All Non-Student Personnel funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Steven E. Lohrenz	PI	PhD	4.2%	No
Vernon Asper	Co-PI	PhD	0 (4.2% in kind)	No
Vince Lovko	Postdoctoral Investigator	PhD	50%	No

3. All Students funded by this project:

None

4. 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.

5. Key Scientific Questions/Technical Issues:

- Develop capability for glider-based optical assessments of algal bloom events in the northern Gulf of Mexico
- Evaluate the utility of underway hyperspectral above-water radiometry for discrimination and mapping of algal bloom phenomena and other optically distinct features in complex coastal waters
- Relate satellite observations to in situ discrete analyses of phytoplankton taxa and environmental variables at selected sites

6. Collaborators/Partners:

Name of collaborating organization: Mote Marine Laboratory

Date collaborating established: Jul 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: Partner has provided assistance in the operation of the Optical Plankton Discriminator, a glider-based sensor that discriminates algal taxa on the basis of spectral absorption signatures.

7. Project Duration:

Feb 2007 – Jan 2011

8. Project Baselines:

Contributions to specific NOAA Goals/Objectives:

NOAA Goal 1. The objectives of this project are closely aligned with NOAA's strategic Ecosystems goal, specifically as it relates to the "Forecasting ecosystem events" research area. The project is directly relevant to the performance objective as stated in NOAA's Five Year Research Plan to "Increase number of regional, coastal, and marine ecosystems delineated with approved indicators of ecological health and socioeconomic benefits that are monitored and understood" and the related NOAA 0-2 Year Milestone to "Define the primary forcing factors and time and space scales that cause HABs and anoxia for selected coastal, ocean, and Great Lakes regions."

Contributions to regional problems and priorities:

The objectives of this project are closely aligned with the Gulf of Mexico Alliance (GOMA) Water Quality priority, which addresses the need "to improve the detection and forecasting of harmful algal blooms (HABs) in the Gulf of Mexico and to better understand the public health and socioeconomic effects of bloom events." Specifically, this project relates to various GOMA 2006-2009 Action Blueprint and Commitments as laid out in the GOMA Governors' Action Plan including participation in "workshops with local, state and federal expert scientists to train personnel in HAB field sampling and microscopic identification methods and to demonstrate toxin-detection methods…", advancing "technologies for rapid field screening and enhanced real-time 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.

How the project has narrowed gaps in regional knowledge, data, model performance, geographic coverage, etc.

This project will expand our understanding of the types of HABs that may occur in the northern Gulf of Mexico and their relationship to environmental conditions that lead to bloom events. At present, there is a lack of information regarding the types of HABs and their frequency and extent in the northern Gulf of Mexico. This project will specifically address that knowledge and data gap. In addition, this project explores the use of new technologies to enhance detection and monitoring capabilities for HABs and algal blooms in general.

9. Objectives/Milestones accomplished in this period

Participation in the Harmful Algal Bloom Control and Mitigation workshop February 9-11, 2010. Sponsors of the workshop included the Florida Fish and Wildlife Research Institute, Mote Marine Laboratory, the Gulf of Mexico Alliance, Solutions to Avoid Red Tide (START) and the Marine Policy Institute at Mote Marine Laboratory. The workshop was held at the Keating Building at Mote in Sarasota, FL. The workshop goals were the following:

1) Present state-funded Red Tide Control & Mitigation project results to stakeholders;
2) Increase awareness and educate human and environmental health managers as well as stakeholders on HAB Control and Mitigation science and strategies;
3) Address Gulf of Mexico Alliance HAB 5 year Workplan Control and Mitigation goals and action items;
4) Highlight, discuss and debate the latest global and Florida specific Control and Mitigation research.

Participation in the NGI Annual Meeting and presentation of poster on project activities (see conference citations below).

We have continued involvement with the Gulf of Mexico Alliance HAB workgroup. Lovko serves as task lead on several tasks in the Governor's Action Plan aimed at ultimately improving our ability to detect, track, predict and mitigate harmful algal blooms in the Gulf of Mexico.

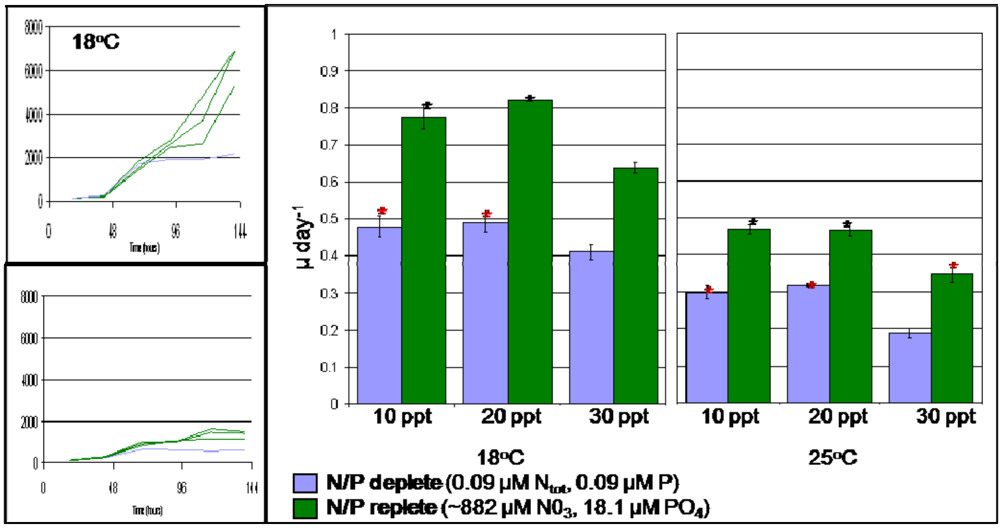
10. Significant research results, protocols developed, and research transitions

Sample collection and analysis continue in conjunction with regular monitoring efforts for discrete analysis of phytoplankton community structure, contributing to a 2+ year time series of the phytoplankton community in the northern Gulf of Mexico (see conference citations below).

As an extension of the NGI phytoplankton work, Lovko has been engaged in collaborative research with Drs. Allen Place and Holly Bowers at the University of Maryland Center for Environmental Science characterizing the growth and toxicity of the ichthyotoxic dinoflagellate, *Karlodinum veneficum* in the northern Gulf of Mexico. Results of this research have been presented at a national and a regional conference (see citations in section 14). Further, with the onset of the Deepwater Horizon spill in the Gulf, efforts have been made to coordinate with other regional phytoplankton researchers to maximize sampling opportunities to evaluate the response of phytoplankton to the oil spill. Numerous samples have been collected from several cruises both within the region of the spill, as well as in areas so far unaffected in order to gain a clear "before and after" picture of the effect of the oil spill on the phytoplankton community. Proposals are being developed to secure funding to further examine this issue.

Research transitions involving standardized methods for toxin detection are being explored in conjunction with GOMA activities.

Figure 40. Results of nutrient enrichment on the growth (µ) of a toxic Mississippi Sound isolate of *K. veneficum* at varying salinity and temperature. Insets show increases in cell density over duration of study (160 hrs). Autotrophic growth of non-feeding *K. veneficum* is typically limited to <0.5 day^{-1} although our results demonstrate growth exceeding 0.8 day-1 for this MS Sound isolate.



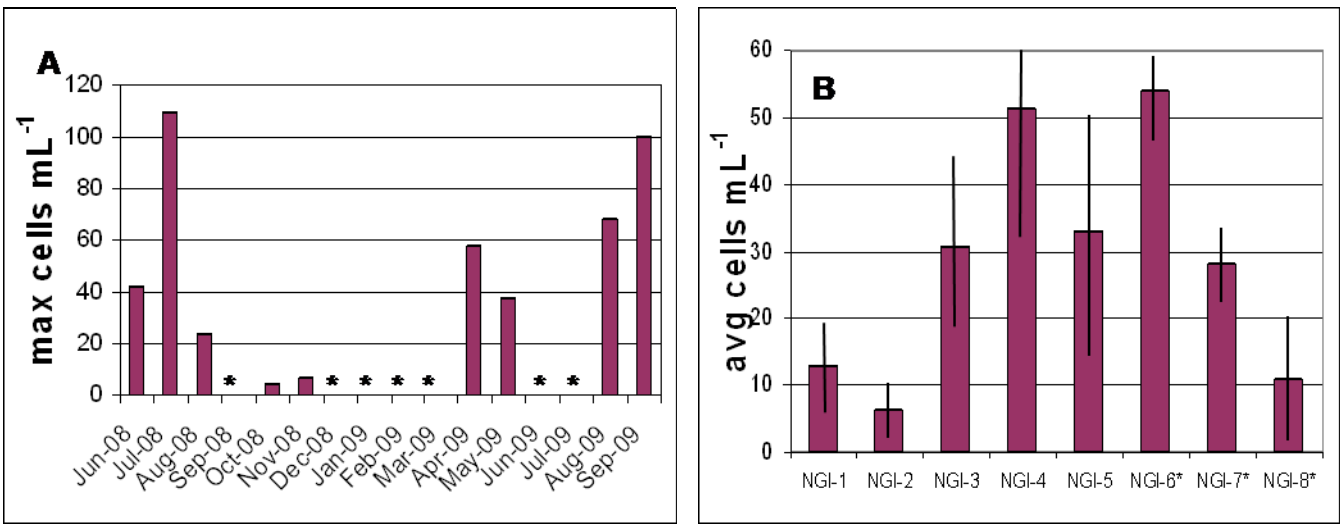


Figure 41. Maximum *K. veneficum* density among all stations for each month of study period. Note; * indicates incomplete data for indicated months. B) Cell density of *K. veneficum* at each station averaged over entire study period. Bars in panel "B" are standard errors (n=16). These results indicate that *K. veneficum* is present, although at low levels, at all stations and during every month sampled.

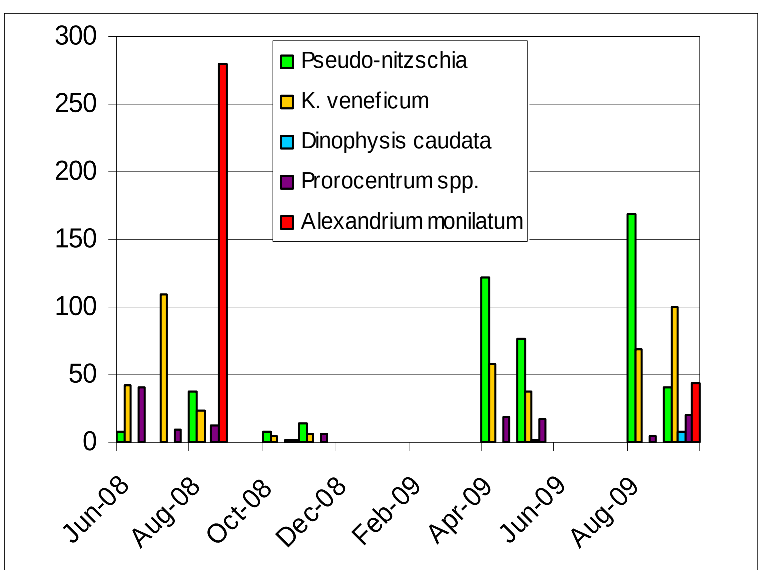


Figure 42. Monthly abundance of major HAB phytoplankton taxa in MS Sound averaged over all stations from June 2008 - August 2009

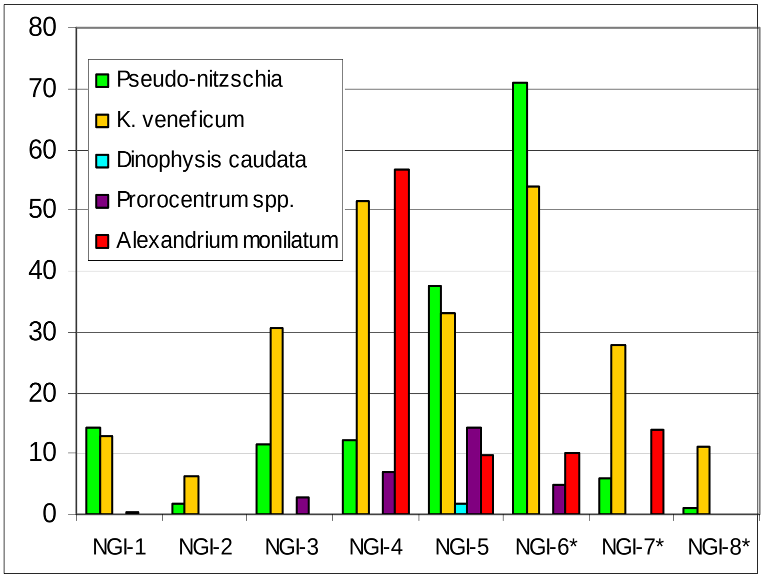


Figure 43. Average abundance of major HAB phytoplankton taxa for each station in MS Sound over 2008-2009.

11. Outreach activities

PIs participated in and presented at several conferences during this reporting period.

12. Peer Reviewed Articles

Lohrenz, S. E., W.-J. Cai, X. Chen, and M. Tuel (2009) Hyperspectral Remote Sensing of Water Mass Properties in a River-Influenced Coastal Region, Technical Proceedings of the Oceans 2009 MTS/IEEE Conference, 26-29 October 2009, Biloxi, MS.

Lohrenz, S., 2009. Interactive comment on “Quantitative observation of cyanobacteria and diatoms from space using PhytoDOAS on SCIAMACHY data” by A. Bracher et al. Biogeosciences Discussions 5, S2824-S2829.

13. Non-refereed articles and reports for this project

None

14. Conference presentations and poster presentations for this project

Dornback, M., S. E. Lohrenz, 2010. Seasonal and Spatial Factors Contributing to Phytoplankton Biomass Variability in the Western Mississippi Sound, Northern Gulf Institute Annual Conference, Mobile, AL, 18-20 May 2010.

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.

Kirkpatrick, G., S. E. Lohrenz, M. Moline, O. Schofield, Derivative analysis of light absorbance in the Optical Phytoplankton Discriminator, 6-10 October 2008, Barga, Italy (poster, contributed).

Lohrenz, S. E., S. Howden, K. Gundersen, and K. Martin, USM Bonne Carré Monitoring Activities, Bonne Carre Coordination Workshop, 13 June 2008, Baton Rouge, LA.

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.

Lovko, V.J., Lohrenz, S.E. and Place, A.R. Detection and Characterization of *Karlodinium veneficum* in the Northern Gulf of Mexico. Fifth Symposium on Harmful Algae in the U.S. 15-19 Nov. 2009, Ocean Shores, Washington.

Lovko, V., H. A. Bowers, R. Place, S. E. Lohrenz, 2010. Characterization and Bloom-Forming Potential of the Toxic, Fish-Killing dinoflagellate *Karlodinium veneficum* in the Northern Gulf of Mexico,

Molina, L. K., D. Redalje, 2010. Phytoplankton Abundance and Species Composition in Coastal Mississippi Waters, Northern Gulf Institute Annual Conference, Mobile, AL, 18-20 May 2010.

15. Personnel from this project hired by NOAA during this reporting period:

None

16. NOAA Sponsor and NOAA office of primary technical contact for this project:

Julien Lartigue, NOAA Office of Oceanic and Atmospheric Research

PROJECT 06-USM-07: QUANTIFYING ECOSYSTEM SERVICES OF DIFFERENT COASTAL HABITAT TYPES

1. Project Leads:

Name	*Title*	*Affiliation*	*Email*
Richard Fulford	Project lead	University of Southern Mississippi	Richard.Fulford@usm.edu
Mark Peterson	Co-PI	University of Southern Mississippi	Mark.Peterson@usm.edu
Harriet Perry	Co-PI	University of Southern Mississippi	Harriet.Perry@usm.edu

2. All Non-Student Personnel funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Richard Fulford	Lead PI	PhD	8.3%	No
Mark Peterson	Co-PI	PhD	8.3%	No
Harriet Perry	Co-PI	MS	8.3%	No
Paul Grammer	Research associate	MS	100%	No
Cindy Gavins	Research associate	BS	33%	No

3. All Students funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Rebecca Haehn	BS	MS	100%	No
Allison Odom	BS	MS	50%	Yes (Pascagoula)

4. Project Abstract:

This project involves 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 and include nutrient recycling, amelioration of anthropogenic stressors, and the promotion of biological production. The focus of this project was to quantify 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 are 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 had 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 addressed links between habitat quality in emergent marsh estuaries and production of estuarine-dependent juvenile fishes. This emphasis area involved modeling habitat change over a broad range of scales that was integrated with fish growth and movement to understand how annual and multi-annual production may be influenced by habitat change. Our approach involved 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 have augmented and validated an existing Habitat-production model (Fulford and Peterson 2006;

Schumaker 1998) and are using the model to make predictions about how potential changes in marsh habitat may affect fish productivity.

Emphasis area 2 addressed how secondary production on sub-tidal oyster reefs is recovering from damage caused by Hurricane Katina and quantified the trophic connections of oyster reefs with the larger pelagic ecosystem. Key aspects of this assessment effort include measuring secondary production at index reefs in western Mississippi Sound and correlating these data with physical conditions, oyster density, and reef location. We also developed 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.

5. Key Scientific Questions/Technical Issues:

The scientific question addressed by this project is how important are two coastal habitat types (coastal salt marsh and oyster reefs) to fishery production. This question is being addressed in stages using mechanistic models combined with empirical data from an index coastal system. The model provides a framework for identification of data gaps and serves as an assessment tool for asking scenario-based questions about habitat loss and alteration. In addition, the model framework represents an important end product of the project as a management tool.

The key ecosystem questions being examined are how much energy is produced per unit time within each habitat type and how much of that energy is exported from the habitat type to the larger coastal ecosystem. Energy export can occur in two ways: it can be transported passively in the form of plankton or detritus, and it can be exported as living biomass. The former is largely a hydrodynamic process, while the latter involves ecological components in the form of food web structure and behavioral variability. Energy transfer efficiency (ETE; proportion of total production recycled or exported) can be estimated with food web models. The amount of ETE that is comprised of export represents a measure of ecological connectivity between a habitat type and the larger ecosystem. This project is intended to measure this component and examine the influence of habitat quality and habitat choice.

6. Collaborators/Partners:

Name of collaborating organization: Dr. Rebecca Allee, NOAA Gulf Coast Services Center

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: 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: Mississippi Department of Marine Resources, Shellfish Division

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: Data collection support provided for assessment of oyster biomass and water quality data for oyster reef study area in western Mississippi Sound. We are collaborating with MDMR in monitoring and assessment of the restoration natural oyster reef after Hurricane Katrina. Our habitat modeling work will provide valuable baseline data on how the reefs are responding to restoration efforts conducted by MDMR.

Name of collaborating organization: Dr. Ken Heck, Dauphin Island Sea Lab

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: We are collaborating with Dr. Heck in the evaluation and comparison of similar oyster reef restoration projects in Mississippi and Alabama.

7. Project Duration:

Feb 1, 2007 – Jun 30, 2010

8. Project Baselines:

Contributions to specific NOAA Goals/Objectives:

NOAA Goal 1. This research addresses NOAA research priorities as described in the NOAA Strategic Plan to ‘Protect, Restore, and Manage the Use of Coastal and Ocean Resources through an Ecosystem Approach to Management’ through data collection and model development in support of Ecosystem models applicable to management.

Contributions to regional problems and priorities:

The project is also directly relevant to the Gulf of Mexico Alliance theme of Ecosystem-based management. The development of modeling tools intended for management is a key milestone in the development and practical application of EBM concepts. The development of these tools will also benefit our collaborating state agency, MDMR.

How the project has narrowed gaps in regional knowledge, data, model performance, geographic coverage, etc.

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.

9. Objectives/Milestones accomplished in this period

TASK	Start Planned/Actual	Scheduled completion Planned/Actual
1. Collect data on juvenile fish distribution	Jan 07/Jan 08	Complete
2. Collect data on oyster reef macrofauna	Jun 07/Aug 07	Complete
3. Collect data on adult sportfish diet	Oct 06/Aug 07	Complete
4. Data analysis and synthesis for modeling	Jun 07/Jan 08	Complete
5. Initial validation of habitat production model	Sep 07/Sep 08	Complete
6. Initial validation of ECOPATH model for oyster reefs	Jan 07/Jan 08	Complete by August 2010
7. Habitat production export analysis	Mar 07/Mar 08	Complete
8. ECOPATH/ECOSIM simulation analysis	Jan 07/Jan 08	Complete by August 2010
9. Synthesis for EBFM	Jan 09/Jan 09	Complete by August 2010

10. Significant research results, protocols developed, and research transitions

We have developed two simulation models for assessment of habitat linkages to fisheries production. These two models are being developed as a part of continuing funding into management tools. All data collected as a part of this project were used as input for model development. Details on this will be available in the project final report.

Salt marsh habitat model – This analysis examined juvenile spot recruitment to the Pascagoula river estuary as an index for habitat selection in salt marsh nursery areas. We were concerned with comparing structural and dynamic habitat variables and their influence on fish movement and choice. The outcome suggests that fish initially choose based on temporally dynamic habitat variables but as these become more optimal structural habitat becomes more important. There is a temporal hierarchy to habitat selection that makes small scale mitigation projects less effective in maintaining fish production that they are at maintaining salt marsh structure.

11. Outreach activities

PIs participated in and presented at several conferences during this reporting period.

12. Peer Reviewed Articles

None

13. Non-refereed articles and reports for this project

None

14. Conference presentations and poster presentations for this project

Fulford, R.F., M.S. Peterson, C.F. Rakocinski, and M. R. Weber. (2006). Identifying critical habitat across multiple scales for estuarine-dependent fishes with a landscape modeling approach. AFS, 10-15 September, Lake Placid, NY

Fulford, R. S., H. Perry, and M. S. Peterson. 2007. Assessing the ecosystem value of various habitat types to fishery production in the Gulf of Mexico. Poster presentation at the Northern Gulf Institute Annual meeting. Biloxi, MS May 2007.

Fulford, R.S., M.S. Peterson, H. Perry, P. Grammer and R. Haehn. 2008. Assessing the ecosystem value of various habitat types to fishery production in the northern Gulf of Mexico. 2nd Annual Northern Gulf Institute Conference, 13-14 May, Biloxi, MS [Poster].

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

Fulford, R.S., M.S. Peterson, H. Perry, P. Grammer and R. Haehn. 2008. Assessing the ecosystem value of various habitat types to fishery production in the northern Gulf of Mexico. 2nd Annual Northern Gulf Institute Conference, 20-21 May, Mobile, AL [Poster].

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. 2nd Annual Northern Gulf Institute Conference, 20-21 May, Mobile, AL [Oral presentation]

Fulford, R. S., M.S. Peterson, and P. Grammer. 2009. Identifying critical habitat across multiple scales for estuarine-dependent fishes with a landscape modeling approach. 2nd Annual Northern Gulf Institute Conference, 20-21 May, Mobile, AL [Oral presentation]

15. Personnel from this project hired by NOAA during this reporting period:

Allison Odom has been hired by NOAA as a cooperative-student employee for the period between January 2010 and June 2011.

16. NOAA Sponsor and NOAA office of primary technical contact for this project:

Julien Lartigue, NOAA Office of Oceanic and Atmospheric Research

PROJECT 09-NGI-MOD-12: DEVELOPMENT OF PROTOTYPE INTEGRATED ECOSYSTEM ASSESSMENTS IN THE NORTHERN GULF OF MEXICO

1. Project Leads:

Name	*Title*	*Affiliation*	*Email*
Michael Carron, Ph.D.	PI	Northern Gulf Institute	MCarron@ngi.msstate.edu
John Harding, Ph.D.	Co-PI	Northern Gulf Institute	Jharding@ngi.msstate.edu
Just Cebrian	Co-PI	Dauphin Island Sea Lab	jcebrian@disl.org

2. All Non-Student Personnel funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Rich Fulford	Co-PI	PhD	10%	No
Mark Peterson	Co-PI	PhD	4%	No
Steve Lohrenz	Co-PI	PhD	2%	No
LSU Unidentified	Research Associate	MS	17%	No
LSU Unidentified	Research Associate	MS	17%	No
LSU Unidentified	Research Support	MS	17%	No
USM Unidentifed	Research Support	MS	50%	No
L. Hendon	Research Support	BS	15%	No

3. All Students funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
DISL Graduate Student	MS	PhD	100%	No
DISL Intern	BS	MS	50%	No

4. Project Abstract:

NGI is collaborating with the National Marine Fisheries Service, the Gulf Coast Services Center and the National Coastal Data Development Center to host two NOAA Integrated Ecosystem Assessment workshop focused on the development of prototype IEAs in the northern Gulf of Mexico, execute the prototype IEA development, and participate in the standardization of data and meta-data for all IEAs. NGI researchers continue to have significant long range data collection and ecosystem research programs and are developing a network for data sharing and analysis using the NOAA/NGI Ecosystem Data Assembly Center (EDAC) servers at Stennis Space Center.

The goal of this work is to begin the process of generating an Integrated Ecosystem Assessment (IEA) for the Gulf of Mexico and to identify a way forward to complete that IEA. The specific objectives are to:

- Identify and summarize IEA Drivers and Pressures for three representative systems in the northern Gulf of Mexico thus completing step 1 of the Levin et al (2008) 5-step IEA process.
- Identify the similarities and differences in Drivers and Pressures among the three systems.
- Formulate an approach to complete the full 5-step IEA process for the Gulf of Mexico.

The representative systems are Perdido Bay, Florida; Mississippi Sound, Mississippi; and Barataria Basin, Louisiana. Drivers and pressures are defined by the National Oceanic and Atmospheric Administration (NOAA) Integrated Ecosystem Assessment Driver-Pressure-State-Impact-Response (DPSIR) Framework, which is a component of an Ecosystem Approach to Management (EAM).

Work began by identifying coastal sites for which the NGI Ecosystem Team had ongoing efforts to collect data, characterize the systems, and engage stakeholders, all key elements in IEA formulation. From

those the list narrowed to three sites that represented a range of physical and ecological characteristics of Gulf-wide importance. Using similar approaches and existing networks of stakeholders, Drivers and Pressures were formulated for each site separately, and then combined into a common list that permitted cross-comparison.

5. Key Scientific Questions/Technical Issues:

Can NGI develop an integrated Ecosystem Assessment prototype beneficial to the entire northern Gulf of Mexico region to address priority needs identified by the Gulf Coast Services Center and needs listed in the Gulf of Mexico Alliance Action Plan?

6. Collaborators/Partners:

Name of collaborating organization: Buck Sutter, National Marine Fisheries Service

Date collaborating established: Jul 1, 2008

Does partner provide monetary support to project? Amount of support? Yes, collaborator is primary funding organization for this project.

Does partner provide non-monetary (in-kind) support? Yes, partner is actively advising participants in development of the prototype.

Name of collaborating organization: Becky Allee, NOAA Gulf Coast Services Center

Date collaborating established: Jul 1, 2008

Does partner provide monetary support to project? Amount of support? None

Does partner provide non-monetary (in-kind) support? Yes, partner is actively advising participating in development of the prototype

Name of collaborating organization: Just Cebrian, Dauphin Island Sea Lab

Date collaborating established: May 29, 2009

Does partner provide monetary support to project? Amount of support? None

Does partner provide non-monetary (in-kind) support? None

Name of collaborating organization: Sara Green, Alaina Owens, and Erick Swenson, Louisiana State University

Date collaborating established: May 29, 2009

Does partner provide monetary support to project? Amount of support? None

Does partner provide non-monetary (in-kind) support? None

Name of collaborating organization: Richard Fulford and Jill Hendon, University of Southern Mississippi

Date collaborating established: May 29, 2009

Does partner provide monetary support to project? Amount of support? None

Does partner provide non-monetary (in-kind) support? None

Name of collaborating organization: William McAnally and Rita Jackson, Mississippi State University

Date collaborating established: May 29, 2009

Does partner provide monetary support to project? Amount of support? None

Does partner provide non-monetary (in-kind) support? None

Name of collaborating organization: Russ Beard and Rost Parsons, NOAA Coastal Data Development Center

Date collaborating established: Jul 1, 2008

Does partner provide monetary support to project? Amount of support? None

Does partner provide non-monetary (in-kind) support? Yes, partner is actively advising participants in development of the prototype, especially the development of data management protocols and metadata standards.

Name of collaborating organization: NMFS Support to the NOAA Diversity Internship Program 2009, NOAA Coastal Data Development Center

Date collaborating established: Jul 1, 2008

Does partner provide monetary support to project? Amount of support? None

Does partner provide non-monetary (in-kind) support? None, this task is to supply funding directly to the NOAA Diversity Internship Program 2009

7. Project Duration:

Jul 1, 2008 – Feb 28, 2010

8. Project Baselines:

Contributions to specific NOAA Goals/Objectives:

NOAA Goal 1. This project directly addresses the goal to protect, restore, and manage the use of coastal and ocean resources through an ecosystem approach to management.

Contributions to regional problems and priorities: How is the project tied to regional issues and priorities? Identify priority stakeholders, e.g., Gulf of Mexico Alliance, specific user groups.

The development of an Integrated Ecosystem Assessment in the Gulf of Mexico has been identified as a priority in the Gulf state's Governor's Gulf of Mexico Alliance action plan.

Gaps: Describe how the project has narrowed gaps in regional knowledge, data, model performance, geographic coverage, etc.

An integrated method of managing important Gulf of Mexico ecosystems has not been developed. NOAA is developing a systematic procedure using a 5-step process. This project intends to assess the first two steps, (1) Scoping (Identify scale and goals of IEA and threats to achieving goals) and (2) Develop ecosystem indicators and threshold levels. These will be applied to two or three northern Gulf ecosystems such as Breton Sound, Mississippi Sound, Perdido Bay, etc.

9. Milestones accomplished in this period

Task 1: Two workshops were held (2-5 Feb 09 and 17-18 Feb 10).

Task 2: Established a coordinated Prototype IEA for the Northern Gulf of Mexico

A multi- university team from Mississippi State University, Louisiana State University, Dauphin Island Sea Lab, and University of Southern Mississippi has been established. The IEA was developed after the workshops. The research team began by identifying coastal sites for which we had ongoing efforts to collect data, characterize the systems, and engage stakeholders, all key elements in IEA formulation. From those we narrowed the list to three sites that represented a range of physical and ecological characteristics of gulfwide importance. Using similar approaches and existing networks of stakeholders, we formulated Drivers and Pressures for each site separately, then forged a common list that permitted cross comparisons. Finally, we evaluated the process for lessons learned and determined a recommended path forward toward the goal of a Gulf of Mexico IEA. Figure 44 illustrates the Drivers and Pressures of the three study areas.

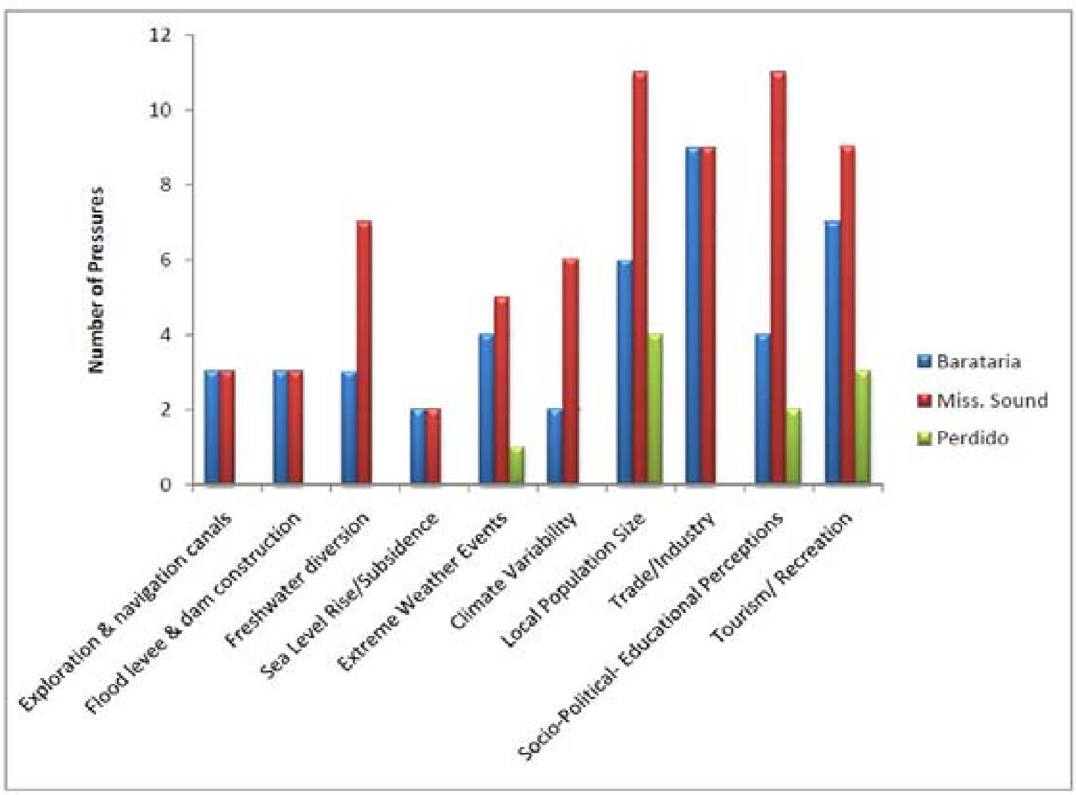


Figure 44. Drivers and Pressures of three study areas in the northern Gulf of Mexico.

10. Significant research results, protocols developed, and research transitions

Drivers and Pressures for each site were formulated separately, then the team forged a common list that permitted cross-comparison. The process for lessons learned was evaluated and provided a plan for the Gulf of Mexico IEA.

This completes step 1 of the Levin et al (2009) 5-step IEA process for three systems in the northern Gulf of Mexico – Barataria Basin, Mississippi Sound, and Perdido Bay. These three systems offer a range of geographic, hydrologic, and population characteristics that is typical of much of the region from the Northern Texas Gulf coast through the Florida Panhandle.

This preliminary analysis has identified Human-Related Processes as the most prevalent IEA Driver category, affecting all three systems. It has further demonstrated that five related Pressures -- Increased Fishing Effort, Urban/Coastal Development, Boat Traffic, Nutrients, and Pollution are common to all three systems.

These three systems can now be examined for the next steps in the IEA process: indicator development, risk analysis, status assessment and management strategy evaluation.

11. Outreach activities

General Description: NOAA IEA Priority Action Task Team

Date: Feb 2-5, 2009

Location: Bay St. Louis, MS

Description: IEA PATT meeting and workshop on the development of prototype IEA for the Gulf of Mexico and other regions

Approximate Number of Participants: 50

General Description: IEA Team Meeting Workshop

Date: Feb 17-18, 2010

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

Description: Team Meeting to finalize statement of objective and approach & assign tasks

Approximate Number of Participants: 10

12. Peer Reviewed Articles

None

13. Non-refereed articles and reports for this project

McAnally, W. H., Jackson, R. E., Cebrian, J., Fulford, R., Green, S., Hendon, J., Lohrenz, S., Owens, A., Peterson, M., Swenson, E., Harding, J., & Lartigue, J. (2010). Integrated Ecosystem Assessment Initiative for Selected Systems in the Northern Gulf of Mexico. Mississippi State University: Northern Gulf Institute. http://www.northerngulfinstitute.org/publications/docs/2010/01/7180SummaryDocumentIEA2010.01.pdf

14. Conference presentations and poster presentations for this project

None

15. Personnel from this project hired by NOAA during this reporting period:
None

16. NOAA Sponsor and NOAA office of primary technical contact for this project:
Buck Sutter, NOAA NMFS, Southeast Services Center

PROJECT 09-NGI-MOD-16: AIR MONITORING AND ANALYSIS AT GRAND BAY NERR

1. Project Leads:

Name	*Title*	*Affiliation*	*Email*
Mike Carron, Ph.D.	PI	NGI/MSU	mcarron@ngi.msstate.edu
Dave Ruple	Co-PI	Grand Bay NERR/MDMR	HDavid.Ruple@dmr.ms.gov

2. All Non-Student Personnel funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Jacob Walker	Research Associate	BS	50	No

3. All Students funded by this project:

None

4. Project Abstract:

Mercury levels in seafood pose a significant human health risk in the Northern Gulf of Mexico. While some mercury sources are local and easily identified, much of the mercury entering the Gulf of Mexico may originate in other parts of the country or world, and enters the system through wet and dry deposition from the atmosphere. Using dry deposition mercury analyzers, gas analyzers (Carbon monoxide, Sulfur dioxide, Ozone, and Nitrogen Oxides), and meteorological data, it should be possible to use atmospheric modeling to identify sources of air-borne mercury deposited in the Gulf of Mexico region. Data is processed and analyzed at NOAA's Air Resources Laboratory. The station at the Grand Bay National Estuarine Research Reserve is one in a network of sites used to generate atmospheric models.

5. Key Scientific Questions/Technical Issues:

Use atmospheric modeling to identify sources of air-borne mercury deposited in the Gulf of Mexico region

6. Collaborators/Partners:

Name of collaborating organization: US Fish and Wildlife Service (USFWS); MS Department of Environmental Quality (MSDEQ); NOAA-Air Resources Laboratory (NOAA/ARL)

Date collaborating established: Summer, 2006

Does partner provide monetary support to project? Amount of support? Yes

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

Short description of collaboration/partnership relationship: NOAA/ARL provides funding for 50% of the salary for the operator of the monitoring station, provides all equipment and technical support, and analyzes all data collected. USFWS has allowed the station to be located on their land. MSDEQ is in the process of installing a wet-deposition Mercury monitoring station at the same site.

7. Project Duration:

Jan 1, 2008 – Sep 30, 2010

8. Project Baselines:

Contributions to specific NOAA Goals/Objectives:

NOAA Goals 1 and 3. Monitoring mercury deposition rates contributes to the understanding of how mercury enters the ecosystem and enters the food chain. To provide a healthy seafood stock, it is necessary to understand where mercury contamination originates.

Contributions to regional problems and priorities:

Mercury Deposition Network (MDN) sites in the National Atmospheric Deposition Program (NADP) have shown that the states in the Gulf of Mexico region receive high levels of mercury deposition compared to other parts of the country. Mercury has made its way into the food chain, and many fish consumption advisories have been made in the Gulf of Mexico region, both in fresh and salt water. Many sport fish in the Gulf of Mexico have mercury concentrations that could be dangerous to human health, including king mackerel, blackfin tuna, and greater amberjack. Monitoring mercury deposition and modeling mercury transport through the atmosphere will help identify sources of mercury within the Gulf of Mexico region, and potentially identify sources from other parts of the country or world.

How the project has narrowed gaps in regional knowledge, data, model performance, geographic coverage, etc.

There are few dry-deposition mercury monitoring sites in the country, so this station will help fill gaps in the understanding of mercury transport through the atmosphere. Experiments are underway at the station to try to determine the amount of mercury coming from the ocean in the form of aerosols as opposed to emissions from human sources, such as coal-burning power plants and chlorine production.

9. Objectives/Milestones accomplished in this period

October 2010 will mark three years of continuous mercury monitoring (3 years of which are under this project).

Figure 45. Mobile mercury monitoring station

10. Significant research results, protocols developed, and research transitions

None

11. Outreach activities

None

12. Peer Reviewed Articles

None

13. Non-refereed articles and reports for this project

None

14. Conference presentations and poster presentations for this project

None

15. Personnel from this project hired by NOAA during this reporting period:

None

16. NOAA Sponsor and NOAA office of primary technical contact for this project:

Richard Artz, NOAA Office of Oceanic and Atmospheric Research/ARL

PROJECT 09-NGI-MOD-17: RISK WISE COMMUNITIES PARTNERSHIP WORKSHOP: DEFINING PARTNERSHIP SOCIAL MARKETING TARGETS: BEHAVIOR, BENEFITS, AND BARRIERS

1. Project Leads:

Name	*Title*	*Affiliation*	*Email*
Jarryl Ritchie	PI	NGI Program Office	jritchie@ngi.msstate.edu

2. All Non-Student Personnel funded by this project:

None

3. All Students funded by this project:

None

4. Project Abstract:

The scope of this effort is for the Northern Gulf Institute in cooperation with the NOAA Coastal Services Center to conduct a social marketing workshop for the Risk-Wise Partnership. The workshop will solicit information to help enhance the Partnership's understanding of their target audience characteristics, attitudes, beliefs, values, behaviors, benefits and barriers to support future social marketing strategies.

5. Key Scientific Questions/Technical Issues:

The workshop will result in foundational materials identifying:

- Key hazard and climate adaptation behaviors to be addressed through the Risk-Wise Partnership.
- Benefits or advantages that the targeted audience identifies with the behaviors.
- Barriers or hindrances to desired behavior change that are identified by the audience.

6. Collaborators/Partners:

Name of collaborating organization: NOAA Coastal Services Center, Charleston, SC

Date collaborating established: May 2009

Does partner provide monetary support to project? Amount of support? $8,000

Does partner provide non-monetary (in-kind) support? None

Short description of collaboration/partnership relationship: NOAA partner in the program collaborating with the development of workshop and conducting the workshop. This group is also the sponsor of the project.

7. Project Duration:

Jun 2009 – Sep 2009

8. Project Baselines:

Contributions to specific NOAA Goals/Objectives:
NOAA Goal 3. Coastal Hazards

Contributions to regional problems and priorities:
Community Resilience

How the project has narrowed gaps in regional knowledge, data, model performance, geographic coverage, etc.
Workshop helped identify key hazard and climate adaptation behaviors to be addressed through the Risk-Wise Partnership, the benefits or advantages that the targeted audience identifies with the behaviors, and the barriers or hindrances to desired behavior change that are identified by the audience.

9. Objectives/Milestones accomplished in this period

May 2009 – Find meeting location and hotel block for workshop participants

June 2009 – Host meeting, pay invitational travel for participants

10. Significant research results, protocols developed, and research transitions
This workshop informed NOAA, the NGI, and its partners' understanding of the challenges in communicating risk and fostering more resilient behaviors in the face of coastal hazards and climate change impacts. NOAA will use the results of this workshop to inform projects that communicate risk information, as well as to guide future social science projects to explore risk perceptions and priority resilience-related behaviors. Similarly, the NGI will use the results to inform planned social science research on perceptions and attitudes related to coastal hazards risks. Results from the workshop will be shared with a range of partners involved in fostering community resilience in the hopes of generating ongoing dialogue about ways to understand risk perception and behaviors and to improve the effectiveness of risk communication efforts.

11. Outreach activities
None

12. Peer Reviewed Articles
None

13. Non-refereed articles and reports for this project
None

14. Conference presentations and poster presentations for this project
None

15. Personnel from this project hired by NOAA during this reporting period:
None

16. NOAA Sponsor and NOAA office of primary technical contact for this project:
Todd Davison, NOAA Coastal Services Center

PROJECT 09-NGI-MOD-18: TROPHIC SUPPORT OF FISHERY PRODUCTION IN SALT MARSHES RELATED TO TIDAL INUNDATION PATTERNS

1. Project Leads:

Name	*Title*	*Affiliation*	*Email*
Brian Fry	PI	Louisiana State University	bfry@lsu.edu
Ronald Baker	Co-PI	NRC/NOAA Fisheries SEFSC	Ronald.Baker@jcu.edu.au

2. All Non-Student Personnel funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Brian Fry	Professor	PhD	8%	No

3. All Students funded by this project:

None

4. Project Abstract:

Coastal salt marshes have been designated as Essential Fish Habitat (EFH) for many fishery species with little understanding of the processes involved in the support of fishery production and how this support varies over geographic scales. Geographic variability in estuarine hydroperiod and marsh inundation patterns can be substantial. For example, mean tidal range within the study area (northern Gulf of Mexico (GoM) and southern Atlantic Coasts of the USA) varies from ca. 0.3 m in the NW GoM to >3 m in parts of the Atlantic. The relative contribution of marsh surface production and other sources to the trophic support of fishery species is therefore likely to vary among regions with differing tidal regimes and thus access to the vegetated marsh surface. Examination of trophic pathways through stable isotope analysis can help to clarify the importance of marsh productivity and geographic variations in the direct contribution of the marsh surface to fishery production. The project will clarify the mechanistic links and processes underpinning the value of marsh habitats in general, and refine the EFH designation by determining regional variations in marsh value related to flooding patterns. It will also provide insights into likely future changes in marsh functioning due to changes in the marsh landscape associated with climate change, sealevel rise, subsidence, and anthropogenic coastal modifications.

5. Key Scientific Questions/Technical Issues:

Do marsh flooding patterns influence the value of marsh habitats for fishery species? More specifically, do tidal flooding patterns of vegetated marsh surfaces regulate their contribution to the trophic support of nekton of fisheries significance?

6. Collaborators/Partners:

Name of collaborating organization: NOAA Fisheries SEFSC

Date collaborating established: Apr 2009

Does partner provide monetary support to project? Amount of support? None

Does partner provide non-monetary (in-kind) support? NOAA personnel conducted the field sampling at 13 marsh sites spanning 2500 km of the Gulf and Atlantic coasts of SE USA, and processed and prepared samples for isotope analysis.

Short description of collaboration/partnership relationship: We worked together on a marsh-related research project, with NOAA personnel collecting samples and Fry at LSU helping with analysis and data interpretation.

7. Project Duration:

Apr 2009 – Sep 2009

8. Project Baselines:

Contributions to specific NOAA Goals/Objectives:

NOAA Goal 1. NOAA has a number of goals and mandates relating to habitat science. The U.S. Commission on Ocean Policy and other independent review bodies have called for the National Oceanic and Atmospheric Administration to implement a coordinated national habitat science program to better understand the relationships between managed fishery species and their habitats. NOAA's mission is 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. NMFS, an agency of NOAA, is the principal steward of fishery species within the U. S. exclusive economic zone NMFS also consults on the conservation and management of fishery species within territorial and international waters. Much of NMFS' habitat-related research and science is directed by the Magnuson-Stevens Reauthorization Act of 2006 (MSRA), which states: "One of the greatest long-term threats to the viability of commercial and recreational fisheries is the continuing loss of marine, estuarine, and other aquatic habitats. Habitat considerations should receive increased attention for the conservation and management of fishery resources of the United States" Essential Fish Habitat (EFH) provisions in the MSRA form the cornerstone of NMFS' mandated habitat responsibilities with respect to fisheries and require Fishery Management Plans to identify and describe EFH, minimize adverse effects of fishing on EFH to the extent practicable, and identify other actions to conserve and enhance EFH. This project addresses the identification of EFH in Gulf estuaries and other estuaries on the southeastern coast of the U.S.

Contributions to regional problems and priorities:

The Gulf of Mexico (GoM) Alliance, including Texas, Louisiana, Mississippi, Alabama, and Florida have released the Governors' Action Plan for Healthy and Resilient Coasts. This plan prioritizes identification and characterization of Gulf habitats as one of five key issues, and the results of our project will benefit this effort. Efforts to develop Integrated Ecosystem Assessments in the GoM also will benefit by improved information on salt marsh functions in estuaries.

How the project has narrowed gaps in regional knowledge, data, model performance, geographic coverage, etc.

Results from this project will help identify salt marshes that support fishery production in GoM estuaries

9. Objectives/Milestones accomplished in this period

Completion of sample processing and analysis, data preliminary data analysis completed and results presented at CERF 2009 (see below), Fry and Baker have designed final analysis of data for publication.

10. Significant research results, protocols developed, and research transitions

None

11. Outreach activities

None

12. Peer Reviewed Articles

None

13. Non-refereed articles and reports for this project

None

14. Conference presentations and poster presentations for this project

Baker R, Fry B, Rozas L, Minello T (2009) Marsh flooding patterns and geographic variability in the trophic support of juvenile nekton. Coastal and Estuarine Research Federation Biennial Conference, Portland Oregon, November 2009.

15. Personnel from this project hired by NOAA during this reporting period:

Ronald Baker was hired on a short-term contract (June – November 2009) to further this and related work commenced during his NRC Post-Doctoral Fellowship with NOAA Fisheries in Galveston.

16. NOAA Sponsor and NOAA office of primary technical contact for this project:

Lawrence Rozas, NOAA NMFS
Thomas Minello, NOAA NMFS

PROJECT 09-NGI-MOD-19: OPTIMIZING THE USE OF LIGHTNING DATA IN SEVERE STORM WARNING ASSESSMENT

1. Project Leads:

Name	*Title*	*Affiliation*	*Email*
Henry Fuelberg	PI	Florida State University	hfuelberg@fsu.edu

2. All Non-Student Personnel funded by this project:

None

3. All Students funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Scott Rudlosky	Graduate Student	MS	100	No

4. Project Abstract:

CG data from the National Lightning Detection Network (NLDN) have been available to NWS offices for approximately a decade. However, only a handful of NWS offices currently use total lightning data from LMAs. Fortunately, all NWS offices will have total lightning data when the GOES-R GLM is launched in 2015.

We propose to use total lightning, model-derived, and radar data to develop algorithms and/or guidelines as to whether a particular storm is likely to require a warning. This severe storm assessment product will be developed using the WDSS-II software, LMA data from Sterling, VA, and radar data from Sterling, VA and Dover, DE. Automated WDSS-II procedures will allow us to examine many storms individual. Our overriding goal is to develop guidance products that will best use total lightning data (IC and CG) in assessing severe storm scenarios. These products ultimately could be beta tested on WDSS-II, and if proven useful, transitioned to the AWIPS environment. They then could be used by the NWS to issue improved warnings, leading to fewer injuries, fatalities, and loss of property.

5. Key Scientific Questions/Technical Issues:

- How can total lightning data optimally be used to assess storm severity?
- What does lightning indicate that is unique?
- Can total lightning data be used in conjunction with radar and model-derived data to better diagnose and nowcast storm severity?
- Is the National Weather Service (NWS) currently using total lightning data to best advantage when assessing severe weather events?
- Is the NWS fully prepared to use data from the upcoming Geostationary Lightning Mapper (GLM) to aid in determining severe weather potential?

6. Collaborators/Partners:

Name of collaborating organization: Tallahassee Weather Forecast Office

Date collaborating established: Jul 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: Cloud-to-ground (CG) data and severe weather expertise. Our CG data are gathered by the Tallahassee WFO, and several individuals also share insights on severe storms events.

Name of collaborating organization: National Severe Storms Lab

Date collaborating established: Jul 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: WDSS-II provides an integral tool for our research, and its advanced use often requires advice from the NSSL. They continue to develop tools that aid our research, and also provide for a better understanding of the needs of the operational community.

Name of collaborating organization: NOAA/NESDIS/GOES-R Program Office

Date collaborating established: Jul 2008

Does partner provide monetary support to project? Amount of support? Full monetary support

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

Short description of collaboration/partnership relationship: Access to in-cloud (IC) lightning data and expertise. Provide full support for the modification grant that currently funds our research. They also provide data from, and background information on, the Washington D.C. Lightning Mapping Array (LMA).

7. Project Duration:

Jan 2009 – Dec 2010

8. Project Baselines:

NOAA Goals 3, 4, and 5. The science priorities of several NWS regions and centers were described in a recent CSTAR request for proposals. The excerpts below provide examples of the gaps that our research aims to fill….

> Eastern Region: "Development of new techniques to utilize lightning information in the forecast and warning process." "Improved detection and warning techniques for low-topped severe convection and tornado development…"

Southern Region: “Development…of multi-sensor technology to detect/identify storm features leading to, and/or associated with, the development of weak…tornadoes and waterspouts…and microburst producing thunderstorms.”

Central Region: “Development of more accurate diagnostic methodologies to interrogate remotely sensed data…..with a focus on severe thunderstorm and tornado environments”

Storm Prediction Center: “Develop operational techniques to synthesize, view, and analyze total lightning, determine association to convective weather, and develop total lightning forecast techniques and products.”

9. Objectives/Milestones accomplished in this period

Development of products – The WDSS-II software includes algorithms to process and view total lightning, model-derived, and radar parameters. We have employed these algorithms to create grids of many lightning and radar parameters. The base products also have been combined to compute higher-order parameters that accurately describe the current state of individual storms.

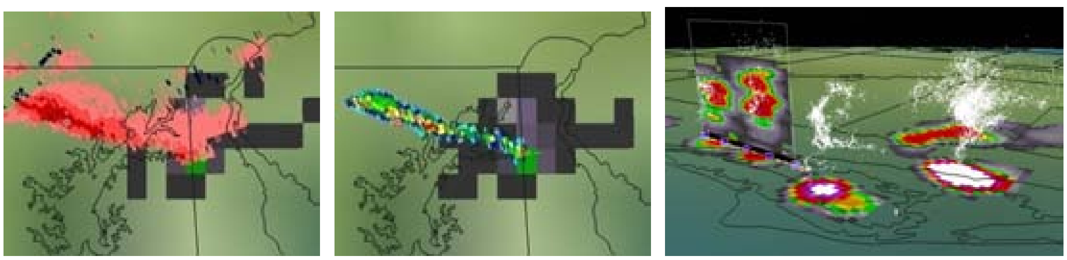


Figure 46. Rotation track, hail swath, and IC lightning data for a tornadic storm on 17 July 2007, and a cross-section of total lightning sources and source density.

Storm clustering and data mining – The WDSS-II software contains an algorithm that is used to identify and track mesoscale features based on user-defined parameters and thresholds. We have determined that the reflectivity at the -20 C isotherm is the best parameter to track both severe and non-severe storms within the Sterling, VA region. This algorithm’s flexibility required detailed consideration of the proper thresholds for tracking coherent features over time. We have determined the optimum set of thresholds, and now are able to mine data from many individual storms.

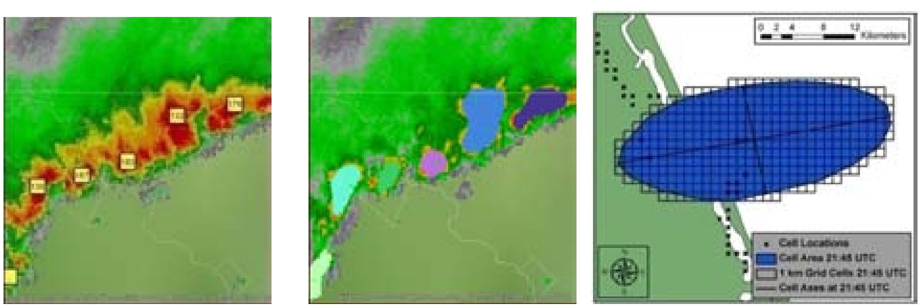


Figure 47. A snapshot of storm cluster IDs with composite reflectivity, the spatial coverage of each cluster, and an example of an idealized storm cluster.

Automated procedures – Our procedures need to be automated in order to create a database of many severe and non-severe storms on many individual days. We have automated our procedures from the base product generation through the identification, tracking, and data mining of individual storm cells. The final output is a table that includes all desired information for each storm that is tracked during a specified period of time (i.e., typically 16-24 hrs).

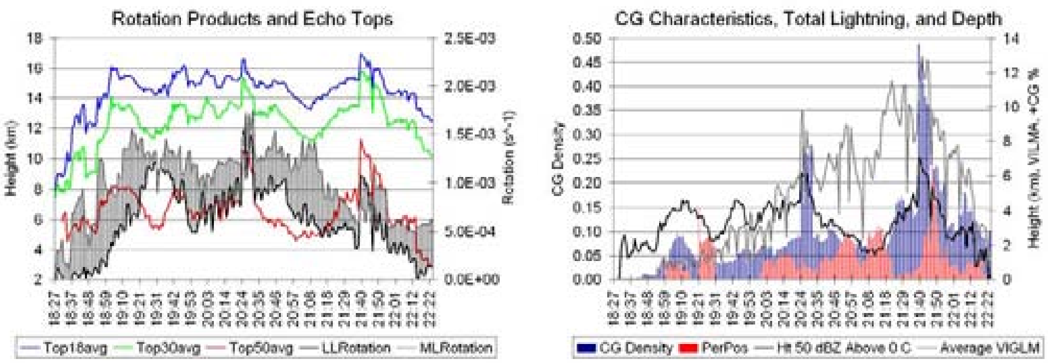


Figure 48. Time series of several lightning and radar parameters during the complete life cycle of an individual severe storm on 10 June 2008.

Manual storm selection – Our automated procedures introduce uncertainty in the coherence of the tracked storm features. This requires the manual selection of severe and non-severe storms from each day. Geographic information system (GIS) techniques were developed to overlay WDSS-defined storm features and severe storm reports. Individual storms are selected based on their location and duration, and classified as severe or non-severe based on their collocation with severe storm reports.

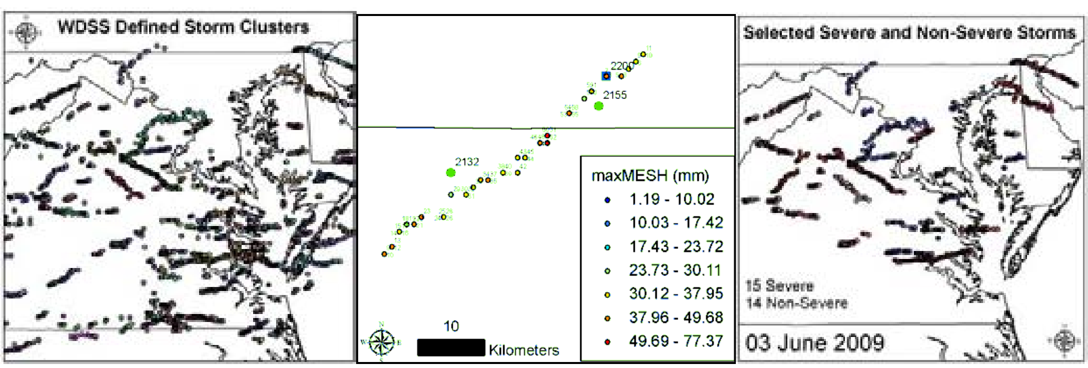


Figure 49. Above: All WDSS-II defined storm clusters on 3 June 2009, an individual storm with severe hail and wind reports, and only the selected severe (red) and non-severe (blue) storms.

10. Significant research results, protocols developed, and research transitions

None

11. Outreach activities

General Description: Ohio State University's 13th Annual Severe Weather Symposium

Date: Apr 17, 2009

Location: Columbus, OH

Description: Invited presentation of "Total Lightning Research and Operational Applications"

Approximate Number of Participants: 150

General Description: KSC Local AMS Meeting

Date: Jun 18, 2009

Location: Patrick Air Force Base, FL

Description: Invited presentation of "Total Lightning Research and Operational Applications"

Approximate Number of Participants: 15

12. Peer Reviewed Articles

Rudlosky, S.D., and H.E. Fuelberg, 2010: Regional distributions of cloud-to-ground lightning polarity, multiplicity and peak current in the contiguous United States. Mon. Wea. Rev.,in press.

13. Non-refereed articles and reports for this project

Rudlosky, S.D., and H.E. Fuelberg, 2009: Investigating total lightning using the Warning Decision Support System—Integrated Information software, Southern Thunder Workshop, 28-30 July 2009, Cocoa Beach, FL, presentation available at http://weather.msfc.nasa.gov/sport/southernthunder/presentations.html.

Rudlosky, S.D., and H.E. Fuelberg, 2010: Determining relationships between lightning and radar in severe and non-severe storms. Vaisala 2010 ILDC/ILMC Lightning Conference, Orlando, April 2010.

14. Conference presentations and poster presentations for this project

Rudlosky, S.D., and H.E. Fuelberg, 2009: Utilizing WDSS-II to automate dataset preparation for a statistical investigation of total lightning and radar echoes within severe and non-severe storms. 4th Conf. Meteor. Applications of Lightning Data, Amer. Meteor. Soc., Phoenix, Paper 2.4.

Rudlosky, S.D., and H.E. Fuelberg, 2009: Utilizing WDSS-II to automate dataset preparation for a statistical investigation of total lightning and radar echoes within severe and non-severe storms. 4th Conf. Meteor. Applications of Lightning Data, Amer. Meteor. Soc., Phoenix, Paper 2.4.

15. Personnel from this project hired by NOAA during this reporting period:

None

16. NOAA Sponsor and NOAA office of primary technical contact for this project:

Steve Goodman, NOAA NESDIS

PROJECT 09-NGI-MOD-20: NOAA/NGI MINORITY SUMMER 2009 INTERNSHIP PROGRAM

1. Project Leads:

Name	*Title*	*Affiliation*	*Email*
Jarryl B. Ritchie	PI	NGI Program Office	jritchie@ngi.msstate.edu

2. All Non-Student Personnel funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Jarryl B. Ritchie	PI	MA	0	No

3. All Students funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Precious Lewis	BS		100	No
Larisa Lee	BS		100	No
Lauren Vasquez	BA		100	No
Jamie Boydston	BA		100	No
Dominique Lazarre	BS		100	NMFS SEFSC, Miami
Matilda Asuzu	HS		100	No
Allison Mojzis	BS		100	No
Ashley Lojek	BS		100	No
Kelly Henry	MS		100	No
Onome Ighoavodha	BS		100	No

4. Project Abstract:

The NOAA /Northern Gulf Institute (NGI) Diversity Internship Program provides career exploration opportunities in coastal science data management, data stewardship for fisheries, and ecosystem data management including metadata development. The internship is open to eligible undergraduate and graduate students, targeting populations underrepresented in NOAA, with an emphasis on those from diverse communities in the northern Gulf of Mexico region. Previous interns included Technology Education, Geographic Information Systems, Computer Science, and Biology majors. Students from all disciplines are welcome to apply for this competitive internship. Social science majors are strongly encouraged to participate. The paid internships last 10 weeks during the summer, with the student interns working full time (40 –hours /week) or working part time to accommodate summer class schedules. The selected applicants receive geospatial metadata training and other basic orientation at the beginning of the summer internship.

5. Key Scientific Questions/Technical Issues:

Provides career exploration opportunities in coastal science, fisheries, and ecosystem management including metadata development to eligible undergraduate and graduate students.

6. Collaborators/Partners:

Name of collaborating organization: NOAA National Coastal Data Development Center, Stennis Space Center, MS

Date collaborating established: Oct 2008

Does partner provide monetary support to project? Amount of support? $14,000

Does partner provide non-monetary (in-kind) support? None

Short description of collaboration/partnership relationship: NOAA partner in the internship program collaborating with the development, operations, and candidate selection processes of the program.

Name of collaborating organization: NOAA NMFS SE Fisheries Region

Date collaborating established: Oct 2008

Does partner provide monetary support to project? Amount of support? $25,000

Does partner provide non-monetary (in-kind) support? None

Short description of collaboration/partnership relationship: Funding partner

7. Project Duration:

Oct 2008 – Sep 2009

8. Project Baselines:

Contributions to specific NOAA Goals/Objectives:
NOAA Goal 1.

Contributions to regional problems and priorities: How is the project tied to regional issues and priorities? Identify priority stakeholders, e.g., Gulf of Mexico Alliance, specific user groups.
Workforce development

9. Objectives/Milestones accomplished in this period

Dec 08 – Design program for 2009, application and program rules development

Jan 09 – Advertise and solicit applications for internship program (through March)

Apr 09 – Identify candidates to fill intern slots and match with science mentors

May 09 – Hire selected candidates for positions

June 09 – Candidates cleared, security passes secured, begin work.

Aug 09 – Candidates complete 10 week internship.

10. Significant research results, protocols developed, and research transitions
None

11. Outreach activities
None

12. Peer Reviewed Articles
None

13. Non-refereed articles and reports for this project
None

14. Conference presentations and poster presentations for this project
None

15. Personnel from this project hired by NOAA during this reporting period:
None

16. NOAA Sponsor and NOAA office of primary technical contact for this project:
Russ Beard, NOAA National Coastal Data Development Center

PROJECT 09-NGI-MOD-21: NOAA/NGI 2009 MISSISSIPPI WATER RESOURCES CONFERENCE STUDENT TRAVEL PROGRAM

1. Project Leads:

Name	*Title*	*Affiliation*	*Email*
Jarryl B. Ritchie	PI	NGI Program Office	jritchie@ngi.msstate.edu

2. All Non-Student Personnel funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Jarryl B. Ritchie	PI	MA	0	No

3. All Students funded by this project:

None

4. Project Abstract:

Northern Gulf Institute/Mississippi Water Resources Research Institute will sponsor presenting graduate students' attendance at the 2009 Mississippi Water Resources Conference August 5-7, Tunica, Mississippi. NCDDC supports multiple federal and state agency, and academic ecosystem programs including those related to watershed management and the impact of the watershed on coastal and ocean waters. The National Oceanic and Atmospheric Administration (NOAA) is very active in providing funding opportunities to students for the purpose of presenting their research and work as it relates to ecosystems and is consistent with NOAA goals. This includes sponsorship and travel expenses to conferences related to the mission of NOAA.

5. Key Scientific Questions/Technical Issues:

Sponsoring presenting graduate students' attendance at the 2009 Mississippi Water Resources Conference

6. Collaborators/Partners:

Name of collaborating organization: NOAA National Coastal Data Development Center, Stennis Space Center, MS

Date collaborating established: May 2009

Does partner provide monetary support to project? Amount of support? $5,000

Does partner provide non-monetary (in-kind) support? None

Short description of collaboration/partnership relationship: National Coastal Data Development Center (NCDDC) is funding $5,000 to support the student sponsorships for the 2009 Mississippi Water Resources Conference.

7. Project Duration:

Jul 1, 2009 – Aug 31, 2009

8. Project Baselines:

Contributions to specific NOAA Goals/Objectives:

NOAA Goal 1.

9. Objectives/Milestones accomplished in this period

Task 2.1 – Provide the list of students sponsored and abstracts of their presentations

Task 2.1 – Final report accounting for sponsorship expenses.

10. Significant research results, protocols developed, and research transitions

None

11. Outreach activities

None

12. Peer Reviewed Articles

None

13. Non-refereed articles and reports for this project

None

14. Conference presentations and poster presentations for this project

None

15. Personnel from this project hired by NOAA during this reporting period:

None

16. NOAA Sponsor and NOAA office of primary technical contact for this project:

Russ Beard, NOAA National Coastal Data Development Center

PROJECT 09-NGI-MOD-22: ADVANCED DATA ASSIMILATION EXPERIMENTS FOR GOES-R SERIES APPLICATIONS

1. Project Leads:

Name	*Title*	*Affiliation*	*Email*
Xiaolei Zou	PI	Florida State University	zou@met.fsu.edu

2. All Non-Student Personnel funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Zhengkun Qin	PostDoc	PhD	50%	No
Xiaolei Zou	Professor	PhD	17%	No

3. All Students funded by this project:

None

4. Project Abstract:

The project is to ingest hourly radiances from the MSG SEVIRI imager data into GSI version for the hourly NAM or WRF. The GSI assimilation system would use FOTO, new strong constraint and a form of digital filter initialization (DFI) applicable to both the NAM and WRF. MSG SEVIRI has 12 channels, and can be used as a precursor to future GOES-R ABI. The focus on high-frequency updating with high-temporal resolution moderate spectral resolution data over a limited forecast domain will provide a useful learning experience for ABI. Conduct some case study using simulated ABI radiances in comparison with observed GOES/MSG imager radiances in situations with severe weather outbreaks and hurricane in the WRF/GSI-based system. For imager data assimilation, crucial information affecting the forward modeling accuracy is the land surface emissivity. The project was also proposed to design a variational system in NAM and WRF including LSE as a state vector. Hyperspectral emissivity data base from IASI and AIRS will be used as first guess and the variation analysis will generate its undated and refined emissivity at wavenumbers of simulated sensors. Impacts will also test a simultaneous analysis of temperature and water vapor fields in variation analysis systems

5. Key Scientific Questions/Technical Issues:

Solve the technical problems in ingesting geostationary satellite radiances with large volumes and develop data thinning process, quality controls of cloudy radiances in 3D-Var/4D-Var systems.

6. Collaborators/Partners:

No collaborators have been identified on this project.

7. Project Duration:

10/01/09 – 09/30/11

8. Project Baselines:

Contributions to specific NOAA Goals/Objectives:

NOAA Goals 3 and 5.

Contributions to regional problems and priorities:

Advance data assimilation systems will help NOAA to improve the severe weather forecasts at Gulf region and other regions.

How the project has narrowed gaps in regional knowledge, data, model performance, geographic coverage, etc.

Uses of high temporal and spatial resolution satellite data in NWP systems are challenging tasks. Direct assimilations of GOES imager radiance data have not been developed at research & operational centers.

9. Objectives/Milestones accomplished in this period

Software and codes have been tested for ingesting GOES& SEVIRI data in WRF models. Several data assimilation experiments were carried out and numerical results were analyzed. Impacts of GOES water vapor channels on precipitation forecast were found to be positive. It was also found that the significance of GOES 11/12 impact depends critically on the accuracy of model's initial conditions, which determines the temporal evolution of dynamic fields that control the locations of precipitation.

10. Significant research results, protocols developed, and research transitions

The assimilation results were presented at 2010 GOES-R Algorithm Working Group Conference and the algorithms will be tested at NOAA-NASA-DoD Joint center for Satellite Data Assimilation (JCSDA).

The findings on the dependence of precipitation forecast accuracy on model's initial condition in this project point to the need of assimilating operationally time-continuous GOES data to better capture important features in the dynamic fields so that improvement in mesoscale precipitation forecast through data assimilation can be extended to more than 9 hours.

11. Outreach activities

None

12. Peer Reviewed Articles

None

13. Non-refereed articles and reports for this project

A conference paper submitted to EUMETSAT user conference in September 2010.

14. Conference presentations and poster presentations for this project

One presentation at GOES-R algorithm working group meeting.

15. Personnel from this project hired by NOAA during this reporting period:

None

16. NOAA Sponsor and NOAA office of primary technical contact for this project:

Fuzhong Weng, NOAA NESDIS

PROJECT 09-NGI-MOD-23/25: DEVELOPING AN UNDERSTANDING OF RESEARCH AND OPERATIONAL NEEDS IN THE GULF REGION FOR THE NOAA UAS PROJECT

1. Project Leads:

Name	*Title*	*Affiliation*	*Email*
Michael Carron, Ph.D.	PI	Northern Gulf Institute	Mcarron@ngi.msstate.edu

2. All Non-Student Personnel funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
David Shaw	PI (followed by M. Carron)	PhD	2	No

3. All Students funded by this project:
None

4. Project Abstract:
This project was to conduct research and analysis of the capabilities of various Unmanned Aircraft Systems (UAS) and their suitability for achieving selected test bed mission requirements by developing multiple operations and logistical support models including cost comparisons and full consideration of the environmental conditions of operations that achieve science data acquisition objectives in various regions. The unique challenges of UAS operations in the Arctic and Gulf of Mexico were specifically addressed.

5. Key Scientific Questions/Technical Issues:
This project is in support of the operational development of the regional test beds in the NOAA UAS project and looks to find alternative scenarios to help NOAA decision makers determine future courses of action to collect data using unmanned aircraft.

6. Collaborators/Partners:
None

7. Project Duration:
Jul 1, 2008 – Jun 30, 2010

8. Project Baselines:

Contributions to specific NOAA Goals/Objectives:
NOAA Goals 3 and 5.

Contributions to regional problems and priorities:
This project and the NOAA UAS project will ultimately contribute to data collection of ecosystems and in tropical systems. The monitoring of critical habitats and predictions of landfall location and storm intensity from tropical systems is an important need identified by the Gulf of Mexico Alliance.

How the project has narrowed gaps in regional knowledge, data, model performance, geographic coverage, etc.

This project fills gaps in NOAA's ability to decide future courses of action concerning the employment of unmanned aircraft systems for data collection and monitoring.

9. Objectives/Milestones accomplished in this period

All milestones concerned delivery of documents listed in section 13 below.

10. Significant research results, protocols developed, and research transitions

All results contained in documents listed in section 13 below.

11. Outreach activities

None

12. Peer Reviewed Articles

None

13. Non-refereed articles and reports for this project

NOAA UAS program Plan (Dec 15, 2009)

NOAA UAS Planning Presentation (Dec 15, 2009)

NOAA UAS Mission Requirements Document (Dec 30, 2009)

NOAA Program Integrated Master Schedule (Dec 7, 2009)

NOAA Concepts of Operations (Dec 14, 2009)

NOAA Analysis of Alternatives (AoA) Report (January 14, 2010)

NOAA UAS Sea Ice AoA Presentation (December 14, 2009)

NOAA UAS Tropical Cyclone AoA Presentation (December 16, 2009)

NOAA Atmospheric Rivers Monitoring AoA Presentation (December 15, 2009)

14. Conference presentations and poster presentations for this project

None

15. Personnel from this project hired by NOAA during this reporting period:

None

16. NOAA Sponsor and NOAA office of primary technical contact for this project:

Robbie Hood, NOAA OAR/ESRL

PROJECT 09-NGI-MOD-24: NOAA COASTAL STORMS PROGRAM – ADCIRC (STORM SURGE) GRID CATALOGING PROJECT

1. Project Leads:

Name	*Title*	*Affiliation*	*Email*
Mike Carron	PI (Yr 1)	NGI	mcarron@ngi.msstate.edu
John Harding	PI (Yr 2)	NGI	jharding@ngi.msstate.edu

2. All Non-Student Personnel funded by this project:

None

3. All Students funded by this project:

None

4. Project Abstract:

Through NOAA's Coastal Storms Program (CSP), an online catalog of unstructured grids used in hydrodynamic modeling projects has been proposed to document existing and future models in the Gulf of Mexico. This unstructured grid catalog (UGC) is intended to provide modelers, coastal managers, and funding agencies with a mechanism of sharing grids and information about projects to help identify modeling gaps and redundancies. Year 1 of this project hosted workshops and produced an assessment of the feasibility of developing a prototype catalog of unstructured grids used in storm surge models. Year 2 of this project supports NOAA's continued development of the prototype catalog through participation in the implementation workshop and on the project team which is reviewing status and recommendations, establishing roles and responsibilities and developing the long-term maintenance plan.

5. Key Scientific Questions/Technical Issues:

Provide modelers, coastal managers, and funding agencies with a mechanism of sharing grids and information about projects to help identify modeling gaps and redundancies.

6. Collaborators/Partners:

Name of collaborating organization: Todd Davison, NOAA Gulf Coast Service Center (GCSC); Rost Parsons, NOAA Coastal Data Development Center (NCDDC)

Date collaborating established: Jul 1, 2008

Does partner provide monetary support to project? Amount of support? $27,500 (year 1), $15,000 (year 2)

Does partner provide non-monetary (in-kind) support? GCSC provides technical guidance, analysis, and prototype development, demonstration and documentation work

Short description of collaboration/partnership relationship: NGI personnel from the NGI program office work closely with the collaborating organization to ensure that the project goals are coordinated with technical personnel in NOAA responsible for modeling storm surge and maintaining databases.

7. Project Duration:

Year 1: 07/01/08 – 09/30/09. NCE approved to 6/30/10

Year 2: 07/01/09 – 07/14/10. NCE approved to 12/31/10 since NOAA evaluation workshop not scheduled until Sep 2010

8. Project Baselines:

Contributions to specific NOAA Goals/Objectives:
NOAA Goals 3 and 5.

Contributions to regional problems and priorities:
Hurricane forecast improvements have been identified as a priority need in the Gulf of Mexico Alliance's Action Plan II, the NOAA Gulf Coast Service Center's Needs Assessment, and the Gulf of Mexico Research Plan (Sea Grant).

How the project has narrowed gaps in regional knowledge, data, model performance, geographic coverage, etc.
This project in collaboration with the NOAA Coastal Storms Program and the Gulf Coast Service Center has developed the information needed to produce an unstructured grid catalog (UGC) for storm surge modeling. The prototype is intended to provide modelers, coastal managers, and funding agencies with a mechanism of sharing grids and information about projects to help identify modeling gaps and redundancies.

9. Objectives/Milestones accomplished in this period
Year 1 milestones included a workshop held in March, 2009 and a white paper, "Development of a National Unstructured Grid Catalog (UGC): Gulf of Mexico Demonstration" produced by the workshop attendees and the Northern Gulf Institute. Year 2 activities have included several teleconferences preparing for the August/ September 2010 evaluation meeting.

10. Significant research results, protocols developed, and research transitions
None

11. Outreach activities
General Description: In Year 1, this project used a workshop to perform outreach to regional coastal storm surge modelers and government personnel engaged in emergency operations and decision making.

Date: Mar 2009

Location: Bay Waveland Yacht Club, Bay St. Louis, MS

Description: Develop a plan to produce a UGC for the Gulf of Mexico

Approximate Number of Participants: 43

12. Peer Reviewed Articles
None

13. Non-refereed articles and reports for this project
None

14. Conference presentations and poster presentations for this project

None

15. Personnel from this project hired by NOAA during this reporting period:

None

16. NOAA Sponsor and NOAA office of primary technical contact for this project:

Todd Davison, NOAA Gulf Coast Services Center
Tina Sanchez, NOAA Gulf Coast Services Center
Rost Parsons, Ph.D., NOAA National Coastal Data Development Center

PROJECT 09-NGI-MOD-26: BALLOON AND PAYLOAD ACQUISITION FOR WISDOM ACTIVITIES DURING THE 2009 HURRICANE SEASON

1. Project Leads:

Name	*Title*	*Affiliation*	*Email*
David Shaw	PI	Mississippi State University	dshaw@research.msstate.edu
Mike Carron	Co-PI	Mississippi State University	mcarron@ngi.msstate.edu
Louis Wasson	Co-PI	Mississippi State University	lwasson@gri.msstate.edu

2. All Non-Student Personnel funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
David Shaw	V.P. Research	PhD	5%	No
Mike Carron	NGI Director	PhD	5%	No
Louis Wasson	Research Associate	MS	17%	No

3. All Students funded by this project:

None

4. Project Abstract:

During the past few years, an increasing number of hurricanes have impacted the southern coast of the United States with devastating results. Some experts have forecast that this trend will continue in the years ahead and in that case, NOAA will certainly be asked to provide highly accurate hurricane-related forecasts over a longer time window prior to landfall. A component to more accurate, longer-range forecasts is a set of measurements taken in the hurricane environment over a significant portion of its lifetime. The challenge will be to develop systems capable of obtaining these important measurements in an economical manner without placing NOAA personnel at increased risk. One such system involves instrumented balloons and the Weather In-Situ Deployment Optimization Method (WISDOM) of operation.

5. Key Scientific Questions/Technical Issues:

NOAA has mandated a 50% increase in hurricane forecast accuracy 3-7 days from possible landfall. The key technical issue is lack of data thousands of miles off shore for hurricane forecast models and how to obtain this scientific data in a safe yet frugal operational system? The intended use of the WISDOM system is to acquire important atmospheric measurements in the synoptic environment around hurricanes in the open oceans. Sensors carried by the WISDOM balloons record GPS, altitude and barometric pressure at 12,000 feet and 26,000 feet and stay aloft up to 10 days. These measurements may lead to a greater understanding of the dynamics driving hurricane track and intensity.

6. Collaborators/Partners:

Name of collaborating organization: NOAA Earth System Research Laboratory (ESRL)

Date collaborating established: May 2008

Does partner provide monetary support to project? Amount of support? $50,000

Does partner provide non-monetary (in-kind) support? Yes, ESRL will provide technical guidance and analysis, work to incorporate data in to prediction models, recommend changes to hardware and protocols, and participate in training and test launches.

Short description of collaboration/partnership relationship: NGI personnel from Mississippi State University and the NGI Program Office will work closely with the collaborating organization to ensure that the project goals are coordinated technical personnel in NOAA responsible for modeling hurricane forecasts of land fall locations, times and intensities. Additionally, NOAA personnel experienced in balloon operations will advise NGI during the development, training and deployment of test balloons.

7. Project Duration:

Jul 1, 2009 – Jun 30, 2010

8. Project Baselines:

Contributions to specific NOAA Goals/Objectives:

This projects directly addresses the NOAA goals #2 …enhance society' ability to plan and respond, #3 Serve society's needs for weather and water information, and #5 Provide critical support for NOAA's mission.

Contributions to regional problems and priorities:

The intended use of the overall system described here is to acquire synoptic weather data around tropical storms (including hurricanes) in the Open Atlantic, Caribbean and Gulf of Mexico. These measurements can be used to lengthen the time window for accurate forecasts of tropical storm descriptive elements. Also, these measurements may lead to greater understanding of the dynamics driving rapid hurricane intensification. Hurricane forecast improvements have been identified as a priority need in the Gulf of Mexico Alliance's Action Plan II, the NOAA Gulf Coast Service Center's Needs Assessment, and the Gulf of Mexico Research Plan (Sea Grant)

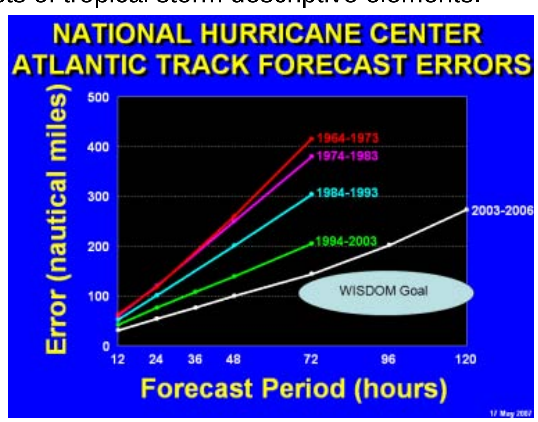


Figure 50. Atlantic Hurricane Track Forecast Track Errors

How the project has narrowed gaps in regional knowledge, data, model performance, geographic coverage, etc.

NOAA is working to reduce forecast errors in hurricane forecasts as shown in Figure 50. The WISDOM goal is illustrated by the white line.

9. Objectives/Milestones accomplished in this period

Launch locations were increased from three to ten for 2009 hurricane season. Sites included Dakar, Azores, Bermuda, Barbados, Puerto Rico, Chincoteaque Island, VA, Tibbee Island, GA, Corpus Christi, TX, Florida Keys and Waveland,MS.

90 balloons were launched at tropical systems from September through November.

A real-time internet accessible WISDOM tracking viewer was implemented by GRI to monitor all WISDOM balloons in flight. It was also used as a promotional tool to the public and media.

Figure 51. WISDOM ballon and instrument package

10. Significant research results, protocols developed, and research transitions

None

11. Outreach activities

General Description: WISDOM Inflation Training

Date: Aug 25, 2009

Location: Stennis Space Center, MS

Description: WISDOM Balloon Inflation Training Session conducted at the NGI offices located at the Stennis Space Center. Attending the training were graduate students from Mississippi State University's GeoScience Meteorology Department and the Harte Institute of Oceanography from the Texas AM Corpus Christi campus, NOAA personnel who deployed to international locations after training and personnel from NGI and the Geosystems Research Institute (GRI) at Mississippi State University (MSU). Tim Lachenmier from Near Space Corporation, the designer and maker of the WISDOM tetroon balloon conducted the inflation training.

Figure 52. WISDOM Balloon Inflation Training Session

Approximate Number of Participants: 20

12. Peer Reviewed Articles

None

13. Non-refereed articles and reports for this project

None

14. Conference presentations and poster presentations for this project

Derek Irby, Jean Mohammadi-Aragh, Robert Moorhead, Phil Amburn, Louis Wasson. WISDOM: Predictive Maps and Visualization. NGI Annual Conference, May 18-20, 2010. Mobile, AL.

15. Personnel from this project hired by NOAA during this reporting period:

None

16. NOAA Sponsor and NOAA office of primary technical contact for this project:

Justyna Nicinska, NOAA Office of Oceanic and Atmospheric Research/LCI

PROJECT 09-NGI-MOD-27: AMOEBANET – TESTING ADVANCED NETWORK CAPABILITIES USING GEOFISH AND OCEANNOMADS

1. Project Leads:

Name	*Title*	*Affiliation*	*Email*
Michael Carron, Ph.D.	PI	Northern Gulf Institute	MCarron@ngi.msstate.edu
Trey Breckenridge	Co-PI	MSU HPCC	Trey@HPC.msstate.edu

2. All Non-Student Personnel funded by this project:

None

3. All Students funded by this project:

None

4. Project Abstract:

This project supported the development of NOAA's NMFS/AFSC. It is in support of NOAA HPCC program. It tested the use of advanced networks to link two existing resources for modeling – the OceanNOMADS server and GeoFish and it test beds the use of a centralized data store with a local applications for advanced modeling and interaction.

5. Key Scientific Questions/Technical Issues:

Test use of a centralized data store with a local applications for advanced modeling and interaction.

6. Collaborators/Partners:

Name of collaborating organization: Mississippi State University, High Performance Computing Collaboratory

Date collaborating established: Jul 1, 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: Equipment will be installed in the facility on MSU's campus for network testing

Name of collaborating organization: NOAA Coastal Data Development Center

Date collaborating established: Jul 1, 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: NCDDC will operate tests from their Stennis Space Center facilities for network and software testing

7. Project Duration:
Jul 1, 2009 – Dec 31, 2010

8. Project Baselines:

Contributions to specific NOAA Goals/Objectives:
NOAA Goal 5

Contributions to regional problems and priorities:
The system and protocols developed and tested by this project will support the NGI Ecosystem Data Assembly Center used by the Gulf of Mexico Alliance for data management of NGI research projects.

How the project has narrowed gaps in regional knowledge, data, model performance, geographic coverage, etc.
This project worked on developing faster interfaces for collaborative data sharing.

9. Objectives/Milestones accomplished in this period
This project required that MSU's High Performance Computing Collaboratory purchase an identical piece of computer equipment to that being installed at the National Coastal Data Development Center (NCDDC), Stennis Space Center, MS. NCDDC installed their equipment the first week of January, 2010. MSU installed their equipment in February, 2010 to complete the project.

10. Significant research results, protocols developed, and research transitions
None

11. Outreach activities
None

12. Peer Reviewed Articles
None

13. Non-refereed articles and reports for this project
None

14. Conference presentations and poster presentations for this project
None

15. Personnel from this project hired by NOAA during this reporting period:
None

16. NOAA Sponsor and NOAA office of primary technical contact for this project:
Tiffany Vance, NOAA NMFS/AFSC

PROJECT 09-NGI-MOD-28: NGI & NCDDC HYPERSPECTRAL IMAGERY SUPPORT TO THE GOMA HABITAT PROJECT FOR GRAND BAY NERR

1. Project Leads:

Name	*Title*	*Affiliation*	*Email*
John Harding (NGI)	PI	NGI	jharding@ngi.msstate.edu
Mark Woodrey (MSU)	Co-PI	MSU-CREC	msw103@ra.msstate.edu

2. All Non-Student Personnel funded by this project:

None

3. All Students funded by this project:

None

4. Project Abstract:

In July, 2009, the Northern Gulf Institute (NGI), the Environmental Cooperative Science Center (ECSC) and Grand Bay National Estuarine Research Reserve (NERR) partnered to conduct a flyover and collect hyperspectral data for the entire Grand Bay NERR. The Grand Bay Reserve encompasses 18,400 acres in southeastern Mississippi between Pascagoula and the Alabama state line. Key habitats include: pine savanna, freshwater marshes, *Juncus roemarianus* (black needlerush) dominated salt marsh, salt pannes, oyster reefs, and seagrasses. This imagery will be one of the largest continuous coverage hyperspectral datasets along the Gulf of Mexico and the only dataset that completely covers a National Estuarine Research Reserve.

5. Key Scientific Questions/Technical Issues:

By collecting a large-scale, complete hyperspectral dataset for the entire Grand Bay NERR, the generated imagery will provide data for multiple projects that will expand and further develop a better understanding of the GB NERR system. The geospatial data collected during this flyover will be valuable to many Grand Bay NERR and ECSC partner groups along the Gulf coast and throughout the country.

6. Collaborators/Partners:

None

7. Project Duration:

07/01/09 – 12/31/09. NCE approved to 6/30/10 due to processing errors found upon data inspection in early 2010. Additional NCE approved until 12/31/10 to allow time for inspection of data collected during reflight of data in May 2010 and scheduled for June/July 2010 delivery.

8. Project Baselines:

Contributions to specific NOAA Goals/Objectives:

These hyperspectral data will be used by NGI, Grand Bay NERR and Dauphin Island Sea Lab in support of research addressing the NOAA Sea Grant Gulf of Mexico Research Plan. This data supports both the NOAA ecosystem and climate mission goals.

Contributions to regional problems and priorities:

These hyperspectral data will be used by NGI, GB NERR and Dauphin Island Sea Lab in support of research addressing the Gulf of Mexico Alliance Action Plan

How the project has narrowed gaps in regional knowledge, data, model performance, geographic coverage, etc.

By collecting a large-scale, complete hyperspectral dataset for the entire Grand Bay NERR not presently available, the generated imagery will provide data for multiple projects that will expand and further develop a better understanding of the GB NERR system.

9. Objectives/Milestones accomplished in this period

New hyperspectral overflights completed over Grand Bay NERR in May 2010

10. Significant research results, protocols developed, and research transitions

Initial hyperspectral data was collected and delivered to the GBNERR on time. Subsequent review found processing errors in the data and new overflights occurred in May 2010. Processed data is scheduled for June/ July delivery with subsequent inspection by personnel at GB NERR.

11. Outreach activities

None

12. Peer Reviewed Articles

None

13. Non-refereed articles and reports for this project

None

14. Conference presentations and poster presentations for this project

None

15. Personnel from this project hired by NOAA during this reporting period:

None

16. NOAA Sponsor and NOAA office of primary technical contact for this project:

Rost Parsons, NOAA National Coastal Data Development Center

PROJECT 09-NGI-MOD-29: DEVELOPMENT OF A NORTHERN GULF OF MEXICO OPERATIONAL FORECAST SYSTEM

1. Project Leads:

Name	*Title*	*Affiliation*	*Email*
Mike Carron	PI	Northern Gulf Institute	mcarron@ngi.msstate.edu
Changsheng Chen	PI	University of Massachusetts-Dartmouth	c1chen@umassd.edu

2. All Non-Student Personnel funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Qichun Xu	Research Scientist	M.S.	10%	None

3. All Students funded by this project:

None

4. Project Abstract:

The NOAA National Ocean Service's Physical Oceanographic Real-Time Systems (PORTS) along the northern coast of the Gulf of Mexico will provide real-time oceanographic data to promote safe and efficient navigation. NGI, through MSU, will manage and coordinate this Operational Forecast System (OFS) UMASS-Dartmouth project activity in the development of a model to support the PORTS. A global or basin-scale model will provide boundary conditions to a proposed northern Gulf of Mexico Shelf domain model. This will cover the continental shelf from the shoreline seaward to approximately the 200 m isobath and from the southern tip of Texas to between Pensacola and Choctawhatchee Bays, Florida. The nGOM Shelf model will provide boundary conditions to three nested OFSs for the Northeastern Gulf of Mexico (NEGOM), the Northwestern Gulf of Mexico (NWGOM), and the Lower Mississippi River (LMR). The NEGOM regional OFS will include the three PORTS locations for Mobile Bay, Pascagoula, and Gulfport. The NWGOM regional OFS will include the three PORTS locations for Lake Charles, Sabine Neches, and Houston/Galveston. The LMR regional OFS will cover the New Orleans PORTS.

The major role of UMASSD team is to help the NOAA National Ocean Service to define the methodology for the development of the nGOM OFS; to describe the technical approach and timeline; and to provide technical assistance in using FVCOM.

5. Key Scientific Questions/Technical Issues:

The nGOM Shelf and nested NEGOM, NWGOM and LMR OFSs require a hydrodynamic model capable of accurately representing larger scale features such as meso-scale eddies and the wind-driven coastal circulation as well as the smaller scale coastal and estuarine circulation associated with complex shorelines, topography and tidal dynamics. Therefore, the Finite Volume Coastal Ocean Model (FVCOM: Chen et. al., 2003), developed at UMASSD has been selected to be tested and applied to this region. FVCOM has been successfully applied in several coastal ocean regions to simulate the hydrodynamics using an unstructured grid. The Northeast Coastal Ocean Forecast System (NECOFS) has been implemented by UMASSD in a real-time mode since 2007 (http://fvcom.smast.umassd.edu/research_projects/NECOFS/index.html) with high-resolution grid nesting functionality. In addition, the application of FVCOM to the Delaware River and Bay, within the context of NOS's Delaware River and Bay Model Evaluation Environment, revealed encouraging FVCOM modeling skills in simulating water levels, currents, salinity and temperature. FVCOM was therefore chosen as the core numerical model for developing an nGOM regional modeling approach.

A key feature in the proposed system is the implementation of a regional model, using the forecasts of a global ocean or basin-scale Gulf of Mexico model to provide open ocean lateral boundary conditions. The regional model is then nested to a series of highly resolved grids to focus in regions of interests, i.e., PORTS. The technique of nesting has made significant advances over the last few years and the NECOFS system has demonstrated high-resolution grid nesting functionality. For prediction accuracy and operational efficiency, a medium grid resolution (5 km to 500 m) model will be set-up to cover the shelf area (nGOM Shelf). nGOM Shelf will use boundary conditions from a global or basin-scale model. The higher resolution (50 m to 500 m) NEGOM, NWGOM and LMR models will then be nested within the nGOM Shelf model to resolve the smaller scale coastal and estuarine circulation features in detail.

NOS has begun the nGOM Shelf domain development. The latest version of FVCOM available from UMASSD was configured for this. The nGOM Shelf model will provide forecasts in Mobile Bay as an initial PORTS demonstration and nesting of the NEGOM OFS will follow. The tasks breakdown for development and implementation of the nGOM Shelf and nested NEGOM OFS model system are: T1. Grid determination; T2. Tidal skill assessment T3. Hindcast skill assessment; T4. Nowcast/forecast system set up; T5. Nowcast/forecast system implementation.

6. Collaborators/Partners:

Name of collaborating organization: NOAA/NOS Coast Survey Development Laboratory, NOAA/NOS Center for Operational Oceanographic Products and Service

Date collaborating established: 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: Drs. Frank Airkman, Eugene Wei and Aijun Zhang are leading the development of nGOM regional and coastal model using FVCOM. This system will be placed into the forecast operation after it is validated using the field measurement data. We have been working together with them to provide the technical support through this funded project.

7. Project Duration:

Jul 2009 – Dec 2010

8. Project Baselines:

Contributions to specific NOAA Goals/Objectives:

NOAA Goal 3. The NOAA/NOS modeling team is developing the forecast modeling system in nGOM. This model system will serve as one of major NOAA operational system linked to the global and region ocean. We have made a significant contribution to this goal with technical support in configuration of FVCOM and solving the coding problems. We also helped NOAA/NOS team in transferring the advanced modeling technology (developed by the UMASSD team) to NOAA for the development of the real-time operational system.

Contributions to regional problems and priorities:

This project is directly related to the regional issues in the Gulf of Merico (GoM). This model system has been used by NOAA/NOS for the assessment of oil spilling occurred recently in the GoM. This system is also designed to predict the physical environment off the LATEX shelf where the hypoxia occurred, and also could be used for the ocean rescue, etc.

How the project has narrowed gaps in regional knowledge, data, model performance, geographic coverage, etc.:

Up to date, there is no a high-resolution model available in the GoM that is capable to resolve multi-scale processes from regional domain to estuaries, particularly to link the Mississippi Delta estuary and wetland to the GoM regional model. This project will help us narrowed this gap. Making the real-time operational model is not very hard, but the difficulty is to make the model realistic and accurate. The development of this model system through intensive comparison with the observation will provide the solid foundation to validate the model.

9. Objectives/Milestones accomplished in this period

We have successfully transferred the updated FVCOM technology to the NOAA/NOS modeling team. The nGOM-FVCOM has been able to run on the NOAA IBM supercomputer. We also have built a partnership with NOAA/NOS modeling team in the system development. The model system has been running and is being validated by the observation.

10. Significant research results, protocols developed, and research transitions

The key objective of this project is to provide the technical support to the NOAA/NOS modeling team in developing the nGOM-FVCOM forecast system. The major efforts have been made in the development of protocols for the operational model to meet the NOAA/NOS need and also transferring the FVCOM technology to the NOAA/NOS modeling team. We have successfully reached these two goals. See the descriptions in (9).

11. Outreach activities

General Description: Collaborating with Drs. Frank Airkman and Aijun Zhang, we organized a FVCOM workshop at the NOAA/NOS Silver Spring headquarters in January 2010 to address the questions raised by NOAA scientists in using FVCOM. Also, we held an international FVCOM workshop in Shanghai in April 2010 to provide an intensive training class for the FVCOM users.

Date: January 28-29, 2010 (Silver Spring) and April 21-23 (Shanghai)

Location: NOAA headquarter at Silver Spring, MD and Shanghai Ocean University

Description: FVCOM user workshop to provide an intensive training class for the NOAA FVCOM users and international FVCOM users.

Approximate Number of Participants: 15 (Silver Spring) and > 100 (Shanghai).

12. Peer Reviewed Articles

None.

13. Non-refereed articles and reports for this project

None.

14. Conference presentations and poster presentations for this project

None.

15. Personnel from this project hired by NOAA during this reporting period:

None

16. NOAA Sponsor and NOAA office of primary technical contact for this project:

Frank Aikman, NOAA/NOS Coast Survey Development Laboratory, NOAA/NOS Center for Operational Oceanographic Products and Service

PROJECT 09-NGI-MOD-30: NOAA/NGI SUMMER 2009 EDAC INTERNSHIPS

1. Project Leads:

Name	*Title*	*Affiliation*	*Email*
Jarryl B. Ritchie	No	NGI Program Office	jritchie@ngi.msstate.edu

2. All Non-Student Personnel funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
No non-students				

3. All Students funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Armand R. Hindrichs	HS		100	Yes, NCDDC
Aspen Nero	HS		100	Yes, NMFS, SE Region Pascagoula Fisheries Laboratory
Micah Elkins	HS		100	Yes, NCDDC

4. Project Abstract:

The NOAA /Northern Gulf Institute (NGI) EDAC Internship Program provides career exploration opportunities in coastal science data management, data stewardship for fisheries, and ecosystem data management including metadata development. The internship is open to eligible undergraduate and graduate students. Previous interns included Technology Education, Geographic Information Systems, Computer Science, and Biology majors. The program is a partnership between NOAA's Coastal Data Development Center and NGI with the institute providing administrative, logistical, and instructive support to the Diversity Internship Program. NGI administers the stipends for the student interns, assists in the selection of the interns, coordinates program activities, and works with the collaborating institutions to support the internship program which started in the spring and finished at the end of the summer.

5. Key Scientific Questions/Technical Issues:

Provides career exploration opportunities in coastal science data management, data stewardship for fisheries, and ecosystem data management including metadata development to eligible undergraduate and graduate students.

6. Collaborators/Partners:

Name of collaborating organization: NOAA National Coastal Data Development Center, Stennis Space Center, MS

Date collaborating established: Oct 2008

Does partner provide monetary support to project? Amount of support? $16,000

Does partner provide non-monetary (in-kind) support? Administration and placement help

Short description of collaboration/partnership relationship: NOAA partner in the internship program collaborating with the development, operations, and candidate selection processes of the program.

7. Project Duration:
May 2009 – Sep 2009

8. Project Baselines:

Contributions to specific NOAA Goals/Objectives:
NOAA Goal 5.

Contributions to regional problems and priorities: How is the project tied to regional issues and priorities? Identify priority stakeholders, e.g., Gulf of Mexico Alliance, specific user groups.
Workforce development

9. Objectives/Milestones accomplished in this period

May 09 - Identify three candidates to fill needed intern slots within NCDDC and Pascagoula Fisheries Laboratory

May 09 – Hire selected candidates for positions

June 09 – Candidates cleared, security passes secured, begin work.

Aug 09 – Candidates complete 10 week internship.

10. Significant research results, protocols developed, and research transitions
None

11. Outreach activities
None

12. Peer Reviewed Articles
None

13. Non-refereed articles and reports for this project
None

14. Conference presentations and poster presentations for this project
None

15. Personnel from this project hired by NOAA during this reporting period:
None

16. NOAA Sponsor and NOAA office of primary technical contact for this project:
Rost Parsons, NOAA National Coastal Data Development Center

PROJECT 09-NGI-MOD-31: THE MISSISSIPPI DIGITAL EARTH MODEL

1. Project Leads:

Name	*Title*	*Affiliation*	*Email*
Scott A. Samson	PI	Mississippi State University	scotts@gri.msstate.edu

2. All Non-Student Personnel funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Scott A. Samson	Professor	PhD	51%	No
Gunnar Olson	Research Associate	MS	100%	No
Nelle Ruffin	Instructor	MS	100%	No

3. All Students funded by this project:

None

4. Project Abstract:

The Mississippi Digital Earth Model is composed of seven framework layers as defined by the Federal Geographic Data Community's National Spatial Data Infrastructure. Data for the MDEM is acquired and managed through joint operations between the Mississippi Department of Environmental Quality and the Mississippi Department of Information Technology Services. The on-going program will be largely self-funded in the long term because of coordinating regular governmental and agency data acquisition plans and efficiencies in coordinating statewide data purchases. In the near term, however, federal funding to help transition research results into an operational implementation in developing the initial data layers and an efficient data delivery system will be necessary.

The Geospatial Education and Outreach (GEO) project portion was developed in response to the limited availability of geospatial data needed by first responders immediately following Hurricane Katrina of August 29, 2005. An assessment was conducted of the educational needs of Mississippi's local governments, especially the localities in the southern portions of the state most susceptible to the effects of hurricanes. A series of intensive 2, 3 and 5 day workshops were compiled that would provide a strong foundation in the fundamentals and applications of GIS. Courses offered range from basic concepts of GIS to advanced, enterprise database management systems. Technical assistance is provided to local governments following classroom preparation as a means to increase the success rate of implementation of GIS in the work place.

A Mississippi law created in 2003 allocates public sector responsibilities for (1) research and education and (2) implementation in remote sensing and geographic information systems. The law's coordination has uniquely positioned Mississippi to leverage federal, state, and local funds to become the national leader in this rapidly evolving technology. The law created the Mississippi Coordinating Council for Remote Sensing and Geographic Information Systems to "set and assure enforcement of policies and standards to make it easier for remote sensing and geographic information system users around the state to share information and to facilitate cost-sharing arrangements to reduce the costs of acquiring remote sensing and geographic information system data." The law requires the Mississippi Department of Environmental Quality (MDEQ) to develop seven base data layers of geographic information for the state, referred to as the Mississippi Digital Earth Model (MDEM).

5. Key Scientific Questions/Technical Issues:

- Geospatial technology transfer to municipal and county governments
- Development and implementation of instructional materials for non-traditional students
- Technology transfer from the classroom to the work place
- Acquisition of high-resolution digital elevation data across Mississippi

6. Collaborators/Partners:

Name of collaborating organization: Mississippi Department of Environmental Quality

Date collaborating established: Jul 1, 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: The Mississippi Department of Environmental Quality has been given the charge by the State of Mississippi to develop the 7 National Spatial Data Infrastructure layers for the Mississippi Digital Earth Model (MDEM). A subcontract was issued from this project to support MDEQ with their tasks.

7. Project Duration:

Jun 1, 2009 – Jul 31, 2011

8. Project Baselines:

Contributions to specific NOAA Goals/Objectives:

NOAA Goal 5. The Geospatial Education and Outreach portion of this project develops and implements educational programs throughout local and state government agencies in Mississippi. The government workforce is becoming increasingly technologically competent in the utilization of the geospatial applications derived from NGI research activities.

Contributions to regional problems and priorities:

The GEO project is empowering local governments in developing community sustainability and resiliency in matters of the management of wetland resources and managing local resources related to natural disasters. In the event of local and regional emergencies. Local communities developing the capabilities and resources to develop and distribute geospatial databases across political lines as well as integrate geospatial databases developed by state, regional and federal government agencies.

The Mississippi Department of Environmental Quality, through a subcontract with NGI, has focused its efforts on completion of a statewide topographic layer, which will include a digital surface model and ground contours. This data layer is one of the seven framework data layers for the Mississippi Digital Earth Model. Previous funding through NOAA provided high-resolution aerial imagery for another framework layer in the MDEM.

How the project has narrowed gaps in regional knowledge, data, model performance, geographic coverage, etc.

Many of the participants in the workshops representing rural local government agencies are unable to purchase GIS software. However, MSU/GRI collaborated with the software vendor ESRI to provide software through a new grant program.

The acquisition, processing and QA/QC activities associated with the high-resolution digital elevation data occurred over the period of this report. The tasks are on-going and should be completed in 3rd quarter of 2010.

9. Objectives/Milestones accomplished in this period

- Since July 1 of 2009, 46 workshops have been delivered to 365 participants representing 37 of the 82 counties in Mississippi.
- MSU/GRI and ESRI collaborated in the development of a software "request for proposals" for rural local government agencies in Mississippi. Fifteen agencies submitted proposals and received software from ESRI. The recipients have 12 months to complete the implementation plan outlined in their respective proposals. Upon successful completion the recipients will receive a long term license for their software. Mississippi was the first state to develop a RFP of this nature for rural, local governments. The software vendor is monitoring the project and will publicize the successful "case studies." Fifteen awards have been delivered to participating local governments. Deadline for completing projects is October 30, 2010.
- The Mississippi Department of Environmental Quality is in the process of acquiring, processing and assessing the QA/QC of the high-resolution digital elevation data across Mississippi. The data will be delivered to the public in the 3rd quarter of 2010.

10. Significant research results, protocols developed, and research transitions

This project is focused on outreach, education and data acquisition. There is not a research component.

11. Outreach activities

Workshops and training: The GEO activities curriculum consists of 10 courses in GIS applications and geospatial database management. Forty-six 2 and 3 day workshops with 365 participants.

12. Peer Reviewed Articles

None

13. Non-refereed articles and reports for this project

None

14. Conference presentations and poster presentations for this project

"Meeting the Continuation Needs of the Geospatial Labor Force Through Workforce Development Programs," American Society for Photogrammetry and Remote Sensing Annual Conference, San Diego, CA, April 2010.

Presentation: "Changing Times, Changing Skills: Meeting the Challenge of Dynamic Geospatial Technologies through Workforce Education," American Society for Photogrammetry and Remote Sensing Annual Conference, San Diego, CA, April 2010.

"gvSIG: Powerful, Multi-Lingual, and Free," American Society for Photogrammetry and Remote Sensing, San Antonio, Texas, November 2009.

15. Personnel from this project hired by NOAA during this reporting period:

None

16. NOAA Sponsor and NOAA office of primary technical contact for this project:

Todd Davison, NOAA Gulf Coast Services Center

PROJECT 09-NGI-MOD-33: NGI SUPPORT FOR GULF OF MEXICO ALLIANCE 2009 GOVERNORS ACTION PLAN IMPLEMENTATION AND INTEGRATION WORKSHOP

1. Project Leads:

Name	*Title*	*Affiliation*	*Email*
Michael Carron, Ph.D.	PI	Northern Gulf Institute	MCarron@ngi.msstate.edu

2. All Non-Student Personnel funded by this project:

None

3. All Students funded by this project:

None

4. Project Abstract:

Participating in the Gulf of Mexico Alliance meetings is important to NOAA and to the NGI mission. Under this effort, NGI will coordinate identifying translators for the Mexican delegation who will be attending the annual GOMA meeting. NGI will also help coordinate the travel and participate in the partnership of the National Estuary Program members in the Gulf of Mexico region.

5. Key Scientific Questions/Technical Issues:

None

6. Collaborators/Partners:

None

7. Project Duration:

Jul 1, 2009 – Dec 31, 2010

8. Project Baselines:

Contributions to specific NOAA Goals/Objectives:

NOAA Goal 5. Provide Critical Mission Support to NOAA

Contributions to regional problems and priorities:

This project is in direct support to the Gulf state’s Governor’s Gulf of Mexico Alliance

How the project has narrowed gaps in regional knowledge, data, model performance, geographic coverage, etc.

This project help the Alliance extend its influence to the Gulf of Mexico Mexican States.

9. Objectives/Milestones accomplished in this period

NGI participated in the Gulf of Mexico Alliance action plan implementation meeting and oversaw the efforts tasked within this project. English/Spanish speaking staff from the NGI university partnership provided interpretation for the Mexican delegation who attended the GOMA annual meeting in Mobile, AL. The proficient interpreters greatly enhanced the level of participation by the Mexican delegation and their efforts were recognized by the conference organizers. In addition, NGI participated in the meeting for National Estuary Program for the Gulf of Mexico region and coordinated travel for the NEP representatives for the northern Gulf region.

10. Significant research results, protocols developed, and research transitions
None

11. Outreach activities
This project is mainly an outreach effort. See milestones accomplished above.

12. Peer Reviewed Articles
None

13. Non-refereed articles and reports for this project
None

14. Conference presentations and poster presentations for this project
None

15. Personnel from this project hired by NOAA during this reporting period:
None

16. NOAA Sponsor and NOAA office of primary technical contact for this project:
Todd Davison, NOAA Gulf Coast Services Center

PROJECT 09-NGI-01: DEVELOPING A TOOL FOR COST EFFECTIVE BEST MANAGEMENT PRACTICES AND RESILIENT COMMUNITIES

1. Project Leads:

Name	*Title*	*Affiliation*	*Email*
G. Wayne Wilkerson	PI	Mississippi State University	gww@ra.msstate.edu

2. All Non-Student Personnel funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
G. Wayne Wilkerson	PI	MA, MLA	9%	No

3. All Students funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Germaina Salazar-Mejia	BS	MS	100%	No

4. Project Abstract:

The goal of this one year project is to develop a decision support tool that will enable the construction industry to design and build more resilient and sustainable communities through the inclusion of best management practices (BMPs) in new commercial and residential construction. Specific tasks include:

Task 1. Complete production of a spreadsheet based application that will include screens for site characterization (already completed), hydrographs, and BMP cost and effectiveness.

Task 2. The second task will identify potential spatial packages capable of linking with the spreadsheet, choose the most viable candidate, and link it with the spreadsheet.

Task 3. Outreach is being conducted to educate interested parties about the status and functions of the application.

5. Key Scientific Questions/Technical Issues:

The primary question this projects attempts to answer is whether or not a spreadsheet based model can be designed and tested that will:

- Simulate surface runoff and pollutant loads as a function of precipitation, site characteristics, and LID/BMP configurations for development sites in the Southeastern U.S.
- Incorporate a spatial component to assist in computing spatial input values.
- Calculate costs for traditional versus LID/BMP solutions.
- Allow various scenarios to be compared for effectiveness and cost.
- Provide a user-friendly interface for ease of use and application.
- Have a spatial component that is in the public domain.

6. Collaborators/Partners:

No collaboration has been established for this project.

7. Project Duration:

Effective Date:	10/01/2009
Initial Expiration Date:	09/30/2010
Approved No Cost Extension Date:	12/31/2010

8. Project Baselines:

Contributions to specific NOAA Goals/Objectives:

NOAA Goals 1 and 3. Once completed, this project will contribute valuable knowledge toward the following NGI and NOAA research initiatives.

- NGI Research Themes
  - Ecosystem –Based Management
  - Geospatial Data/Information And Visualization In Environmental Science
    - "Focused on data integration techniques and geospatial technologies and decision support tools that enable improved regional ecosystem policy, management and forecasting".
- 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."
  - Weather and Water Mission Goal
    - Performance Objective – "Reduce uncertainty associated with weather and water decision tools and assessments."
    - Weather and Water Strategies – "Employ scientific and emerging technological capabilities to advance decision-support services and educate stakeholders."
- 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."
    - Performance Objective – "Increase number of coastal communities incorporating ecosystem and sustainable development principles into planning and management."
    - 3-5 Year Milestones – "At least 25% increase in NOAA's applied, non-economic social science research capacity to support increased research focus on social, cultural, and policy aspects of eco-system-based approaches to management.
- 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."

Contributions to regional problems and priorities:

A successful completion of this project will benefit the private sector more than the public/research sector. A survey of design professionals in the NGI services areas of Louisiana, Mississippi, and Alabama indicated an overwhelming (70%) number would use such a tool if available. BMPs will need to be installed to test the model. In this regard, the public agencies involved with these test sites will reap the water quality benefits generated.

How the project has narrowed gaps in regional knowledge, data, model performance, geographic coverage, etc.

Background research already completed indicates that no model currently exists that can both simulate surface run-off and link a graphical interface to a spatial engine. This model will be a major contribution to the current practice of stormwater analysis. Also, once completed, this model/ tool can, and should, be customized to work in any geographic region.

9. Objectives/Milestones accomplished in this period

DB Development	Spatial Linkage
A1.Work on DB sheets. (A test product is complete.)	B1. Develop selection matrix. (complete)
	B2. Select graphic model. (complete)
	B3. Collect required code. (complete)

10. Significant research results, protocols developed, and research transitions

Task 1. Significant progress was made regarding the database interface. Ms. Salazar has created a new screen that takes into consideration the effects of installing a weir with the study area. Ms. Salazar will continue to refine this interface through the remainder of calendar year 2010.

Task 2. MapWindows™ GIS Open Source version 4.8.1 was downloaded and installed on May 27, 2010. Users of ESRI Arcview™ will be very comfortable with the package, since the interface is virtually the same. A screen shot of the interface has been included as an attachment to the report. Several plug-ins, which are similar to the application being developed in task 1, were downloaded and tested. A sample of development code and a developer tutorial were downloaded the same day. The PI met with Ms. Salazar on June 3, 2010 to review the new software application and to decide how to proceed. He described to her which data sets would be collected through MapWindows and how it would populate LIDIA. The PI instructed MS. Salazar to download a copy of MapWindows and begin to familiarize herself with the package.

11. Outreach activities

General Description: Met with Jackson County, MS (Pascagoula) officials to discuss installing BMPs at new facilities being constructed.

Date: May 20, 2010

Location: Pascagoula, MS

Description: The PI met with four Jackson County supervisors to educate them about the beneficial value of installing stormwater BMPs as part of a new administrative building complex. The PI received a follow-up e-mail from the county administrator about a potential meeting later in the month of June. The plan is for the PI of this research effort to assist the leaders with the facility design. Pre and post development information will be collected for use in testing the model being completed as part of this contract. The completed facility will also be used for future training and demonstration workshops.

Approximate Number of Participants: 7

12. Peer Reviewed Articles

G. Wayne Wilkerson, William H. McAnally, James L. Martin, Jeff A. Ballweber, Kim Collins Pevey, Jairo Diaz-Ramirez, and Austin Moore. *Latis: A Spatial Decision Support System to Assess Low-Impact Site Development Strategies.* Advances in Civil Engineering Volume 2010 (2010), Article ID 810402, 18 pages. http://www.hindawi.com/journals/ace/2010/810402.html

13. Non-refereed articles and reports for this project

None

14. Conference presentations and poster presentations for this project

G. Wayne Wilkerson, et. al. *Developing a Tool for Assessing Cost Effective Best Management Practices for Resilient Communities.* Presented at the 2010 Northern Gulf Initiative (NGI) Conference. Mobile, AL. May 18-20, 2010.

15. Personnel from this project hired by NOAA during this reporting period:

None

16. NOAA Sponsor and NOAA Office the primary technical contact:

Julien Lartigue, NOAA Office of Oceanic and Atmospheric Research

PROJECT 09-NGI-02: FROM PHYSICS TO FISH: MODELING THE EFFECT OF PULSED RIVER DIVERSION ON FISH DISTRIBUTION

1. Project Leads:

Name	*Title*	*Affiliation*	*Email*
Dubravko Justic	Lead	Louisiana State University	djusti1@lsu.edu
Kenneth Rose	Co-PI	Louisiana State University	karose@lsu.edu
Chunyan Li	Co-PI	Louisiana State University	cli@lsu.edu
Haosheng Huang	Co-PI	Louisiana State University	hhuang7@lsu.edu
Lawrence Rozas	Co-PI	NOAA Fisheries Service	Lawrence.Rozas@noaa.gov

2. All Non-Student Personnel funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Dubravko Justic	PI	PhD	8.3%	No
Kenneth Rose	Co-PI	PhD	8.3%	No
Chunyan Li	Co-PI	PhD	8.3%	No
Haosheng Huang	Co-PI	PhD	8.3%	No
Lawrence Rozas	Co-PI	PhD	0%	Yes – NOAA Fisheries Service, Lafayette, LA
Asif Hoda	Post doc	PhD	25%	No

3. All Students funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Yi Du	MS	PhD	0%	No

4. Project Abstract:

Pulsed freshwater diversions on the Lower Mississippi River are increasingly being used to combat coastal land loss. An issue that arises with diversions is their effects on aquatic biota in the area. How do pulsed releases of freshwater affect the spatial distribution and health of ecologically and economically important fish and invertebrate species downstream? This is a critical question to address if these diversions are to be used for wide-scale coastal restoration. Our project combines hydrodynamics (physics), water quality, and individual-based fish models into a single integrated “physics to fish” model, and examine how changes in salinity, temperature, and water quality resulting from diversions affect several key fish species. We are formulating a “physics to fish” model based on the Caernarvon River Diversion (CRD) and Breton Sound Estuary. The CRD provides a good test case – it has been operating since 1992 and has been the subject of several large-scale studies (i.e., PULSES, NUMAN, and most recently NGI) designed to monitor how pulsed releases affect water quality and key aquatic biota. There are also existing datasets and models for this system that have been developed from previous projects that will make it easier to develop our models. With prior support of NGI, we have implemented the Finite Volume Coastal Ocean Model (FVCOM) to the coastal northern Gulf of Mexico. As a part of this effort, we have extended the model grid to the upper Breton Sound all the way to the CRD. FVCOM is being coupled with a simple nutrient-phytoplankton-zooplankton (N-P-Z) model of the Breton Sound that was previously developed within the PULSES project. Finally, the individual-based fish model is being developed to simulate the movements of thousands of individuals in the same 3-dimensional spatial grid as used by the hydrodynamics model. Each individual’s position in the grid will be tracked in continuous

space on an hourly time step, and each fish will experience the water velocity, salinity, temperature, and water quality in the cell within which it is located. Our individual approach is similar to the classical particle tracking approach, except that our particles can exhibit complicated movement behavior. The effects of pulsed releases will be simulated for individuals that represent freshwater versus euryhaline species types (e.g., largemouth bass versus spotted seatrout) and highly versus less mobile species types (e.g., fish versus shrimp). We will examine both the short-term (days) and longer-term (weeks to months) influences of different diversion release scenarios on fish distributions and environmental conditions experienced by exposed fish. Our project will provide a quantitative tool to be added to the toolbox for assessing the effect and utility of river diversions for coastal restoration. Our model addresses the issue of diversions causing significant shifts in the spatial distributions of key fish species, and whether the rapidity of changes in environmental conditions can cause stress in individual animals. These research endpoints are highly relevant to the Gulf of Mexico ecosystem research and the missions of NOAA, NGI, GOMA and Sea Grant.

5. Key Scientific Questions/Technical Issues:

Coastal Louisiana has been the site of massive wetland loss, with rates as high as 100 km^2 yr^{-1}, amounting to about a quarter of the nearly 2 million ha which existed at the beginning of the century. This loss is attributed to a complex interaction of factors, including elimination of riverine sediment input to coastal wetlands (primarily due to flood control levees on the Mississippi River), altered wetland hydrology, and high relative sea-level rise. Controlled river diversions that create pulses of freshwater that flood wetlands are being increasingly used for coastal restoration. Most scientists and managers agree that diverting a fraction of the lower Mississippi River water back into coastal wetlands would slow down the coastal land loss. However, an issue that arises with diversions is their effects on aquatic biota in the area. Diversions may increase nutrient inputs and thus alter the spatial and temporal dynamics of productivity within the system. Nutrient inputs can also create eutrophication problems in estuaries adjacent to the diversion sites and, with large-scale diversions, could affect the coastal waters of the northern Gulf of Mexico, where a seasonally severe hypoxic zone has persisted for over twenty years. In addition to altered productivity, diversions can also cause significant shifts in the spatial distributions of key aquatic fauna. How do pulsed releases of freshwater affect the spatial distribution and health of ecologically and economically important fish and invertebrates downstream? Do the animals experience physiological stress due to rapidly changing environmental conditions? Answering these questions is critical for the effective design and implementation of diversions for wetland restoration.

6. Collaborators/Partners:

LSU scientists are collaborating with Dr. Lawrence Rozas of NOAA who participates in this project as unfunded collaborator. Over the past decade or more, Dr. Rozas has been investigating how aquatic fauna community structure responds to river pulsing and other perturbations in a variety of locations in coastal Louisiana, including Breton Sound. Our group is also collaborating informally with Dr. Shaye Sable of the Louisiana Department of Wildlife and Fisheries, and with Dr. Brian Piazza, the Atchafalaya Program Manager at the Nature Conservancy. Dr. Sable is involved with developing and using other modeling approaches than the particle tracking proposed here for examining how river pulsing affects fish community composition on marshes, and Dr. Piazza is involved with collecting and analyzing field data on diversion affects on aquatic fauna composition and spatial distributions in the upper portion of Breton Sound. Our project is coordinated with other NGI efforts at LSU and with DELTA observation system developed with funding from a Shell grant to LSU. DELTA observation system collects a variety of physical, chemical and biological information from fixed platforms and surveys in the Breton Sound estuary. Our connections to state agencies in Louisiana ensure that decision makers are informed about our proposed project. Project scientists participate, as appropriate, in stakeholder meetings such as the

Caernarvon Interagency Advisory Committee (CIAC), whose members represent all major stakeholders of the region.

7. Project Duration:

10/1/2009 - 9/30/2011

8. Project Baselines:

Contributions to specific NOAA Goals/Objectives:

The proposed research directly addresses NOAA's Ecosystem Mission Goal: Protect, Restore and Manage Use of Coastal and Ocean Resources through Ecosystem Approaches to Management, by contributing to three specific research areas outlined in the NOAA 5-year Research Plan (NOAA, 2008): (1) Advancing understanding of ecosystems to improve resource management, (2) Forecasting ecosystem events, and (3) Developing integrated ecosystem assessments and scenarios, and building capacity to support regional management.

Contributions to regional problems and priorities:

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. Research activities within this project significantly contribute to the two of the four NGI research themes: (1) Ecosystem Management – Characterize northern Gulf of Mexico coastal wetland and fisheries habitats, including restoration strategies, and, (2) Coastal Hazards – Strengthen the integration of watershed, estuarine and coastal models in the northern Gulf of Mexico. Further, our research supports the Gulf of Mexico Alliance (GOMA) Water Quality Proposal for Action Plan #2 (Objective WQ4) by developing management tools that inform decision makers about existing water quality conditions and potential changes that could result from coastal land-use decisions. Lastly, the proposal addresses five of the top six research topics identified by the ongoing Sea Grant Gulf of Mexico Research Plan Strategic Planning Process: (1) Freshwater input and hydrology, (2) Connectivity of habitats and habitats to resources, (3) Water quality and nutrients, (4) Ecosystem health indicators, and (5) Sediment management and river diversion.

How the project has narrowed gaps in regional knowledge, data, model performance, geographic coverage, etc.

Our project will provide a quantitative tool to be added to the toolbox for assessing the utility and effects of river diversions for coastal restoration. Our model addresses the issue of diversions causing significant shifts in the spatial distributions of key fish species and whether the rapidity of changes in environmental conditions can cause stress in individual animals. The area of animal movement is a relatively new discipline and the idea of vertically integrated or "physics to fish" modeling is gaining momentum in oceanography and coastal sciences. Our effort is a small but important step in the direction of developing physics to fish modeling tools relevant to the Gulf of Mexico ecosystem and to the missions of NOAA, NGI, GOMA and Sea Grant.

9. Objectives/Milestones accomplished in this period

- We conducted literature review and developed a database of historical data on hydrodynamics and water quality in the upper Breton Sound Estuary.
- As a case study, we implemented FVCOM model to the upper Breton Sound Estuary, including the Caernarvon Diversion site. The model grid extends to the surrounding land areas to allow for wetting and drying of adjacent marshes. We performed initial FVCOM calibration using the flow data collected during the 2001 PULSES experiments.

- Currently, FVCOM is being coupled to a simple nutrient-phytoplankton-zooplankton (N-P-Z) model. Also, individual-based fish model in which particles exhibit complicated movement behavior (i.e. smart particles) is being constructed and tested.

10. Significant research results, protocols developed, and research transitions

We simulated hydrodynamics and passive particle movement in the Caernarvon River Diversion (CRD) and Breton Sound Estuary under different freshwater discharge scenarios. Numerical simulation results indicated that pulsing diversion discharge enhances water exchange between wetlands and adjacent water bodies and reduces the residence time in the whole estuary.

11. Outreach activities

The proposed research involves a significant amount of modeling research, with opportunities for student training in both graduate and undergraduate settings. The project also advances the educational mission 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 (http://www.lsu.edu/university_relations/oceancommotion/). Project results from LSU NGI contribute to this program by demonstrating how high-end computing and information from different disciplines is combined for use in ecosystem management. Participants in our project will contribute to community outreach by participating in stakeholder meetings, such as the Caernarvon Interagency Advisory Committee (CIAC), whose members represent all major stakeholders of the region. CIAC members include fishery representatives (oyster, shrimp, and recreational fishers), representatives of local governments, local landowners who care about the environment, and natural resource agencies (LA Depts. of Wildlife and Fisheries, Natural Resources (DNR), Environmental Quality, and Health and Human Resources; and US Fish and Wildlife Service, National Marine Fisheries Service, EPA, and Army Corps of Engineers).

12. Peer Reviewed Articles

Justic, D., Wang, L. 2009. Application of Unstructured-Grid Finite Volume Coastal Ocean Model (FVCOM) to the Gulf of Mexico Hypoxic Zone. Proceedings of the 2009 MTS/IEEE conference, Ocean Technology for Our Future: Global and Local Challenges, 26-29 October 2009, Biloxi, Mississippi, MTS, ISBN No. 978-0-933957-38-1.

13. Non-refereed articles and reports for this project

None

14. Conference presentations and poster presentations for this project

Huang, H., Justic, D., Rose, K., Li, C. 2010. From Physics to Fish: Modeling the Effects of Pulsed River Diversion on Fish Distribution. 2010 Northern Gulf Institute Annual Conference, May 18-20, 2010, Mobile, Alabama (Oral presentation).

Du, Y., Huang, H., Justic, D., Rose, K., Li, C., Twilley, R. 2010. Barotropic Tidal Simulation in the Gulf of Mexico: Research Efforts at LSU. 2010 Northern Gulf Institute Annual Conference, May 18-20, 2010, Mobile, Alabama (Poster presentation).

Huang, H., Justic, D. 2009. A Hydrodynamic Model for Breton Sound Estuary (Louisiana): Impact of Pulsing River Discharge on Water Exchange and Residence Time. The 11th International Conference on Estuarine and Coastal Modeling (ECM 11), Seattle, Washington (Oral presentation).

Justic, D. 2009. High resolution water quality models for the northern Gulf of Mexico: Can biology and people keep up with computers? Texas A&M University Seminar, College Station, November 30, 2009 (Invited talk).

Rose, K., Creekmore, S., Craig, K., Thomas, P., S. Rahman, Justic, D. 2009. Does hypoxia have population-level effects in coastal fish? The Society of Environmental Toxicology and Chemistry 30th Annual Meeting, New Orleans, Nov 19-23, 2009 (Oral presentation).

Justic, D., Wang, L. 2009. Application of unstructured-grid, finite volume coastal ocean model (FVCOM) to the Gulf of Mexico hypoxic zone. The 20th Biennial Conference of the Coastal and Estuarine Research Federation, November 1-5, 2009, Portland, Oregon (Oral presentation).

Huang, H., Justic, D. 2009. Hydrodynamic response to pulsing river diversion in Breton Sound Estuary, Louisiana. The 20th Biennial Conference of the Coastal and Estuarine Research Federation, November 1-5, 2009, Portland, Oregon (Oral presentation).

Justic, D., Rose, K., Li, C., Wang, L., Hoda, A. and A. Das. 2009. Development of 2-D and 3-D water quality models for coastal Gulf of Mexico. 2009 NGI-Shell Fall Workshop, October 2, 2009, Baton Rouge, Louisiana (Oral Presentation).

15. Personnel from this project hired by NOAA during this reporting period:

None

16. NOAA Sponsor and NOAA Office the primary technical contact:

Julien Lartigue, NOAA Office of Oceanic and Atmospheric Research

PROJECT 09-NGI-03: RIVERINE AND ESTUARINE CARBON EXPORT TO THE COASTAL OCEAN, NORTHERN GULF OF MEXICO

1. Project Leads:

Name	*Title*	*Affiliation*	*Email*
Brian Fry	PI	Louisiana State University	bfry@lsu.edu
R. Eugene Turner	Co-PI	Louisiana State University	euturne@lsu.edu
Dubravko Justic	Co-PI	Louisiana State University	Djusti1@lsu.edu

2. All Non-Student Personnel funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
E. Swenson	Research Associate	M.S.	10%	No
C. Milan	Research Associate	M.S.	5%	No
Asif Hoda	Post-doc	PhD	10%	No

3. All Students funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Anindita Das	BS	PhD	15%	No
Philip Riekenberg	BS	MS	10%	No

4. Project Abstract:

This project will study carbon export dynamics and transformations in the river and the bay, addressing three hypotheses: (1) The Barataria Bay is a net sink for atmospheric CO_2 on an annual basis, but may be a seasonal source of CO_2 during some months; (2) The Mississippi River is a net source of atmospheric CO_2 on an annual basis, with seasonal highs and lows that are related to fluctuations in temperature and turbidity; (3) The bay and the river each export about the same amount of labile organic carbon to the coastal ocean. This project couples field and modeling approaches to determine net carbon export from the Mississippi River and Barataria Bay. We will use long-term monthly data collected over 10+ years in the bay to estimate the average DIC (dissolved inorganic carbon), DOC (dissolved organic carbon) and POC (particulate organic carbon) gradients. New field measurements will estimate the turnover of these carbon pools and pCO_2. We will use a detailed hydrodynamic model for the bay to compute carbon export fluxes and use remote sensing to help calibrate storm-associated fluxes that may dominate the annual carbon export budgets.

5. Key Scientific Questions/Technical Issues:

Rivers and estuaries both are important sources of carbon for the coastal ocean. Inorganic carbon exports are important for pCO_2 fluxes related to the atmosphere and changing global carbon budgets, while the export of organic carbon as dissolved and particulate materials can be important to coastal food webs and, in some cases, the creation and maintenance of hypoxia Riverine export in the Gulf of Mexico is dominated by the MR that provides >95% of freshwater entering the Gulf. This river supplies a large carbon load, but the lability of this material may be low, <5% degradable over the 1-3 months that river water stays on the Louisiana shelf The MR also supplies nutrients to local deltaic estuaries such as BB where phytoplankton growth may be very high due to river inputs at the mouth of the estuary. Our proposal will compare and contrast the carbon export dynamics in the MR and BB using hydrodynamic models in conjunction with field measurements to budget ecosystem production, consumption and export of DIC (dissolved inorganic carbon), DOC (dissolved organic carbon) and POC (particulate organic carbon). Experimental studies of carbon turnover rates will help check these flux estimates, and allow us to address our research hypotheses:

1) The BB is a net sink for atmospheric CO_2 on an annual basis, but may be a seasonal source of CO_2 during some months.

2) The MR is a net source of atmospheric CO_2 on an annual basis, with seasonal highs and lows that are related to fluctuations in temperature and turbidity.

3) The BB and the MR each export about the same amount of labile organic carbon to the coastal ocean.

6. Collaborators/Partners:

No collaboration has been established for this project.

7. Project Duration:

July 1, 2009 to June 30, 2011

8. Project Baselines:

Contributions to specific NOAA Goals/Objectives:

The proposed work addresses NOAA, NGI, GOMA and Sea Grant research goals. The current NOAA 5-year research plan points toward the importance of improving knowledge of the ocean carbon cycle (Section 6.4.2 Climate Forcings). Our focus on quantifying the export linkages between bays, rivers and coastal ocean relates to the NGI Ecosystem Management goals of improving knowledge of the connectivity between systems. The proposed creating of data-based estimates of carbon budgets will be linked to nutrient dynamics that are of central concern to GOMA goals of managing nutrient inputs and reducing impacts of these nutrients to coastal ecosystems. Our focus on water quality, nutrients and ecosystem connectivity addresses goals in Sea Grant strategic planning. Our carbon focus also addresses larger concerns about ocean acidification and managing coastal landscapes for carbon neutrality.

Contributions to regional problems and priorities:

The research addresses concerns about C budgets where there is little inshore pCO_2 data for the Gulf of Mexico. The proposed research will provide initial data for the northern Gulf, and help improve understanding of these C patterns with state-of-the-art measurements and modeling. Our goal is to see if the carbon loadings arising from human alterations of coastal systems can be managed better and how. Research emphasizing pCO_2 and related pH relationships also is relevant to concerns about ocean acidification.

How the project has narrowed gaps in regional knowledge, data, model performance, geographic coverage, etc.

Too early in the project to address this issue. However, we expect to contribute we will use our strong modeling approach to estimate outwelling, alkalinity and pH effects of the river and Barataria Bay on acidification of the coastal ocean.

9. Objectives/Milestones accomplished in this period

A pCO2-O2 instrument was ordered and arrived just before the Deepwater Horizon oil spill began. We are making plans for sampling as soon as we are sure that field work can be conducted within the context of the oil spill cleanup activities in the middle of our proposed sampling sites. Some restrictions apply for field activities like we are making, including housing limitations and boat access.

Model development and applications are underway, as planned

The Lability experiments are underway.

10. Significant research results, protocols developed, and research transitions

A high resolution 2-dimensional model was used to examine how the reintroduction of different amounts of fresh water from freshwater diversions affects hydrodynamics, salinity and water quality in the Barataria estuary. The effects of different diversions on salinity are most apparent in the middle and lower sections of the Barataria estuary (stations 8-26). The upper parts of the estuary are almost always fresh and the excess fresh water from Davis pond has little impact on the salinity in that area. Also, the Davis Pond discharge, even when the diversion is running at maximum capacity, has little impact on salinities in the lower Barataria Bay (stations 1-7). This is likely because of strong marine influence in this region adjacent to the Gulf of Mexico. A simple nutrient-phytoplankton-zooplankton (NPZ) model was coupled to the 2-D hydrology-hydrodynamic model to simulate temporal and spatial patterns of phytoplankton distribution for different diversion scenarios. The model overestimated the observed chlorophyll a values most of the time 2-D while underscoring the complex patterns of phytoplankton biomass distributions in the estuary. Model simulations clearly demonstrated the importance of residence times for the overall functioning of the estuary. Model simulations also pointed out the differences in spatial patterns in phytoplankton response to distributed freshwater and nutrient inflows near and far from the freshwater inflow sites, reflecting the near-field control of nutrients and far-field control of residence times on phytoplankton standing stock.

11. Outreach activities

None

12. Peer Reviewed Articles

None

13. Non-refereed articles and reports for this project

None

14. Conference presentations and poster presentations for this project

Justic, D., Wang, L., Hoda, A., Das, A. 2010. From box models to mega models: Can biology and people keep up with computers? ASLO/NABS 2010 Joint Summer Meeting, June 6-11, 2010, Santa Fe, New Mexico (Oral Presentation).

Das, A., Justic, D., Swenson, E. M., Hoda, A., Inoue, M., Park, D. 2009. Water, Carbon and Nitrogen Fluxes in a Deltaic Estuary: The Outwelling Hypothesis Revisited. The 20th Biennial Conference of the Coastal and Estuarine Research Federation, November 1-5, 2009, Portland, Oregon (Oral presentation).

15. Has anyone from this project been hired by NOAA during this reporting period?

None

16. NOAA Sponsor and NOAA Office the primary technical contact:

Julien Lartigue, NOAA Office of Oceanic and Atmospheric Research

PROJECT 09-NGI-04: SPATIAL VARIATION AND TEMPORAL TREND OF WATER QUALITY IN THE NORTHERN GULF OF MEXICO

1. Project Leads:

Name	*Title*	*Affiliation*	*Email*
ZhongPing Lee	PI	Mississippi State University	zplee@ngi.msstate.edu
Laodong Guo	PI	University of Southern Mississippi	Laodong.Guo@usm.edu

2. All Non-Student Personnel funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
ZhongPing Lee	PI	PhD	4%	No
Laodong Guo	Co-I	PhD	5%	No
Qiang Dong	Post Doc	PhD	30%	No
HuiJun He	Postdoc	PhD	45%	No

3. All Students funded by this project:

None

4. Project Abstract:

There is a strong need to systematically produce validated water-quality products from satellite measurements for northern Gulf waters. This project will conduct ground truth observations and standardize algorithms to produce and evaluate the spatial and temporal variations of water quality parameters, i.e., concentrations of suspended organic matter (SOM) and suspended inorganic matter (SIM), and water clarity, in the northern Gulf of Mexico. Tasks under this project will include: 1) conduct ground truth measurements in key water-quality parameters in the water column; 2) refine/develop remote sensing tools that can be applied to satellite images for derivation of SOM, SIM and water clarity in Gulf waters; and 3) acquire and process MODIS and/or MERIS images to derive time series of the spatial distributions of water clarity and concentrations of SOM and SIM. These products will provide 1) basis for future prediction of ecosystem health in a changing environment; and 2) a valuable clue if the significant population drop in New Orleans after Hurricane Katrina caused any changes in the surrounding ecosystem. We will obtain a baseline of the water-quality status of the broad northern Gulf waters, but also continuous monitoring of waters in its spatial and temporary variability, and ultimately help the establishment of interrelationships between water quality and land-use, human impacts and environmental changes in the northern Gulf.

5. Key Scientific Questions/Technical Issues:

1) How does water quality varies spatially?
2) How does water quality varies seasonally?
3) How does water quality varies inter-annually?

6. Collaborators/Partners:

Name of collaborating organization: Naval Research Laboratory

Date collaborating established: Jul 1, 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: Help on data acquisition and processing

7. Project Duration:

Oct 1, 2009 – Dec 31, 2010

8. Project Baselines:

Contributions to specific NOAA Goals/Objectives:

NOAA Goal 1. Protect, restore, and manage use of coastal and ocean resources

Contributions to regional problems and priorities:

Products will provide help understanding and evaluation of hypoxia and red-tide events.

How the project has narrowed gaps in regional knowledge, data, model performance, geographic coverage, etc.

Provides in-depth knowledge of water clarity as well as nature of suspended matters in waters of the Northern Gulf of Mexico.

9. Objectives/Milestones accomplished in this period

Acquired and processed historical data from field samples;

We have acquired archived data collected in Mobile Bay, and in the northern Gulf of Mexico waters during the past four cruises. This was done through collaboration with Dr. William McAnally at MSU and Dr. Steve Lohrenz and Kevin Martin at USM. These data include measurements of concentration of suspended sediments, euphotic zone depth (Z_{eu}) calculated from PAR profiles, CDOM fluorescence, beam attenuation, and other parameters. Match-up satellite data for some stations have also been processed. These data will help to refine/develop remote sensing algorithms for the derivation of water-quality parameters in northern Gulf of Mexico.

Collected new measurements in the field;

During the funding period, we have participated in a major sampling cruise covering the Mississippi River plume in the northern Gulf of Mexico during March 2010 to collect physical data and chemical samples. Samples collected for this project include remote-sensing reflectance (Rrs) using a hand held spectrometer. In addition, we also collected dissolved organic carbon and its stable isotope, particulate organic carbon and its stable isotopes.

We have also begun collecting monthly water samples at a series of stations along a salinity gradient across the Mississippi Sound, Mississippi Bight and the Gulf of Mexico. Water samples will be processed for the measurements of colored-dissolved organic matter (CDOM), dissolved organic carbon, particulate organic matter, total suspended particulate matter (SPM), and other water quality parameters. Sample processing and analysis and data acquisition are well under way.

Processed MODIS and MERIS satellite images to derive water-quality properties.

Water clarity product of the Northern Gulf of Mexico is now derived from MODIS and MERIS measurements with pre-developed standard algorithm. Evaluation of spatial and temporal variations will be initiated shortly.

Figure 53. True-color image of the northern Gulf of Mexico (MERIS, Feb. 6, 2007). "Whitish" patch of waters are evident in the lower left corner.

10. Significant research results, protocols developed, and research transitions

"Whitish" patch of waters in the northern Gulf of Mexico are constantly observed from ocean color satellite imageries (Figure 53). With a newly developed optical index (particle backscattering ratio), we are able to confidently classify that these "whitish" waters are dominant with inorganic particles suspended in the upper water column. Further, with remotely sensed particle optical properties, the concentration of the inorganic portion of matters was estimated (Figure 54).

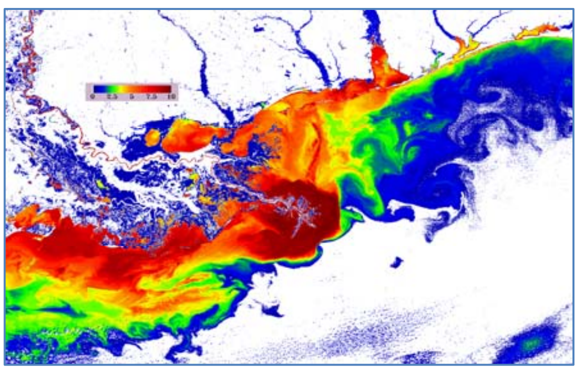


Figure 54. Distribution of concentration (mg/l) of the inorganic portion of particles estimated from remote sense measurements.

11. Outreach activities

None to report

12. Peer Reviewed Articles

ZhongPing Lee, Robert Arnone, Chuanmin Hu, P. Jeremy Werdell, Bertrand Lubac, "Quantification of uncertainties in remotely derived optical properties of coastal and oceanic waters", Ocean Sensing and Monitoring II, edited by Weilin (Will) Hou, Robert A. Arnone, Proc. of SPIE Vol. 7678, 1-8, 2010.

13. Non-refereed articles and reports for this project

None

14. Conference presentations and poster presentations for this project

Zhongping Lee, Laodong Guo, Bertrand Lubac, Changchun Huang, Dongshan Ko, "White patch in the Northern Gulf of Mexico: An observation from ocean color imageries", NGI Annual Meeting, May 18-20, 2010, Mobile, AL.

Zhongping Lee, Laodong Guo, Changchun Huang, Kevin Martin, Steven Lohrenz, "Spatial variation and temporal trend of water quality in the northern Gulf of Mexico", NGI Annual Meeting, May 18-20, 2010, Mobile, AL.

Zhou, Z., Guo, L., "Variations in optical properties of dissolved organic matter along a salinity gradient in the Bay of St. Louis estuary," NGI Annual Conference, May 18-20, 2010, Mobile, AL.

15. Personnel from this project hired by NOAA during this reporting period:

None

16. NOAA Sponsor and NOAA Office the primary technical contact:

Julien Lartigue, NOAA Office of Oceanic and Atmospheric Research

PROJECT 09-NGI-05: SEDIMENT AND MERCURY PATH FATE MODELING

1. Project Leads:

Name	*Title*	*Affiliation*	*Email*
W. H. McAnally	PI	Mississippi State University	mcanally@ngi.msstate.edu
D. W. Evans	Co-PI	NOAA - Cntr for Coastal Fisheries and Habitat Rsch	David.W.Evans@noaa.gov
K. S. McNeal	Co-PI	Mississippi State University	Karen.mcneal@msstate.edu
J. L. Martin	Co-PI	Mississippi State University	jmartin@cee.msstate.edu

2. All Non-Student Personnel funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Colleen Rochelle	Research Scientist	BS	100	Cntr for Coastal Fisheries and Habitat Research
John Cartwright	Research Associate	MS	50	No
Jairo Diaz	Research Faculty	PhD	50	No
Rita Jackson	Research Associate	MS	50	No
Sandra Ortega	Research Associate	MS	50	No

3. All Students funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Chris Hall	MS	PhD	50	No
Kim Pevey	MS	PhD	75	No
Nate Clifton	BS	MS	50	No
John Ramirez	MS	PhD	100	No

4. Project Abstract:

Two previous NGI projects dealt with sediment and mercury in the Mobile Bay area. *Mobile Bay Sediment Modeling* tested existing transport models and created a suite of models for sediment and related contaminants, such as mercury. *Mercury Bioaccumulation in Mobile Bay* provided 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. This project will build on those two efforts.

Sediments are the main repository of mercury in the coastal Gulf of Mexico as well as the site of transformation of inorganic mercury to methylmercury, the more toxic form that is bioaccumulated through food webs. Resuspended sediments are a major transport vector for total mercury and methylmercury. The redistribution of mercury-containing sediments is a critical determinant of where in the coastal environment mercury will become a problem. Sediment characteristics such as texture and organic matter content help determine the extent to which inorganic mercury is transformed to methylmercury. Our proposed work finds common cause with GOMA's Nutrient Impacts Action Plan because algal production that results from eutrophication is a source of sediment-deposited organic matter and consequent hypoxia, both of which can stimulate mercury methylation. Nutrient inputs and their control are likely drivers leading to mercury bioaccumulation. Another area of extension will include the measurement of sulfide in sediments to determine potential inhibition of mercury uptake by methylating bacteria and hence methylmercury production.

Our ultimate goal is to provide a suite of methods to predict the path and fate of sediment and mercury in the Gulf coastal region from entry point to fish stocks.

5. Key Scientific Questions/Technical Issues:

How does mercury move through Gulf Coast estuarine systems? How does its association with fine sediment and algae affect the modes of transport and retention? How does mercury bioaccumulate in specific species? How can management measures mitigate mercury bioaccumulation?

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.

The models and data resulting from this project will enable managers and environmental regulators to better address mercury problems in the Northern Gulf of Mexico. It will provide tools to simulate and evaluate alternate mitigation and mercury source reduction scenarios at sites throughout the Gulf.

6. Collaborators/Partners:

Name of collaborating organization: Weeks Bay NERR

Date collaborating established: 2008

Does partner provide monetary support to project? Amount of support? None

Does partner provide non-monetary (in-kind) support? Yes, boat and personnel time.

Short description of collaboration/partnership relationship: We share data and NERR staff advise us on data collection, provide boats and operators.

Name of collaborating organization: US Army Corps of Engineers

Date collaborating established: 2006

Does partner provide monetary support to project? Amount of support? None

Does partner provide non-monetary (in-kind) support? Yes, personnel time and data

Short description of collaboration/partnership relationship: Mobile District provides data and advice. ERDC provides field and monitoring advice and use of Corps software.

7. Project Duration:

Sep 2009 – Sep 2011

8. Project Baselines:

Contributions to specific NOAA Goals/Objectives:

- Strategic Goal #1: Protect, restore, and manage the use of coastal and ocean resources through an ecosystem approach to management;
- Strategic Goal #3: Serve society’s needs for weather and water information;

- Strategic Goal #4: Support the Nation’s commerce with information for safe, efficient, and environmentally sound transportation;
- 20-year Vision goal of advances in *Ecosystem approaches to the management of coastal and ocean resources*, particularly the goal of, *The physical mechanisms and links between our physical environment and the biosphere must be further studied, explored, and monitored …*

Contributions to regional problems and priorities:

- Gulf of Mexico Alliance’s (GOMA) Action Plan II priority topic “Mercury and Other Contaminants”, including Action Step WQ3.1.2, *Quantify the major input pathways for mercury to the Gulf of Mexico*
- Weeks Bay NERR – identification of mercury and sediment pathways in reserve.
- 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 mercury data, adds new mercury measurements, and watershed modeling as inputs to 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 Weeks 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 Weeks Bay.)

How the project has narrowed gaps in regional knowledge, data, model performance, geographic coverage, etc.

- Numerical model WASP has been improved to link with hydrodynamic drivers and to provide more realistic modeling of sediment and mercury behavior in estuarine flows.
- Numerical models of Weeks Bay and tributary areas have been created.
- Sediment budget for Weeks Bay completed.
- Data on mercury and methylmercury concentrations in waters of Weeks Bay are rare or non-existent. This project is providing the new measurements of methylmercury in this estuary to greatly expand the limited number obtained in ou preceding Mobile Bay mercury study. We are applying an existing food web model for Weeks Bay to model mercury bioaccumulation. We are identifying locales of mercury methylation in Weeks Bay. We are developing methods to extend our modeling approaches to other Northern Gulf of Mexico estuaries.

9. Objectives/Milestones accomplished in this period

1st Quarter CY 2010 (All completed)

a. Initial meetings by team and with stakeholders and outreach project

b. Modeling and database frameworks established
c. Available data identified for compilation

2nd Quarter CY2010 (all completed)
d. Database initiated
e. Field & lab measurement plan designed and initiated

10. Significant research results, protocols developed, and research transitions

- Developed benthic chambers to measure methylmercury fluxes from Weeks Bay Sediments
- Cooperated with MSU partners in joint sampling in Weeks Bay June 3-7, 2010. Shared samples and learned of one another's techniques and approaches. Gained knowledge of the bay's characteristics through direct observation and consultation with reserve staff.
- Collected surface waters for methylmercury analysis
- Collected surface sediment samples and cores for total and methylmercury analysis.
- Deployed chambers for the first time in Weeks Bay June 3-7, 2010 and collected water and sediment samples for analysis
- Collected sediment and porewater samples for total mercury and methylmercury analysis.
- Identified an existing Ecopath model as the basis for our mercury foodweb modeling (Lisa Althauser, 2003. An Ecopath/Ecosim Analysis of an estuarine foodweb" Seasonal Energy Flow and Response to River-flow Related Perterbations. Master of Science thesis. Louisiana State University. We have assembled a database of mercury and stable carbon, nitrogen, and sulfur isotope values in resident biota with which to parameterize this model.

11. Outreach activities

None

12. Peer Reviewed Articles

None

13. Non-refereed articles and reports for this project

John Ezell, 2010, The Sediment and Water Column Biogeochemistry of Weeks Bay During Bottom Water Hypoxic and Norm-oxic Events. MS Thesis, Mississippi State University.

J. N. Diaz-Ramirez, W. H. McAnally, and J. L. Martin, 2010, A Review of HSPF Evaluations on the Southern United States and Puerto Rico. American Assoc Ag & Bio Engineers.

14. Conference presentations and poster presentations for this project

None

15. Personnel from this project hired by NOAA during this reporting period:

None

16. NOAA Sponsor and NOAA Office the primary technical contact:

Julien Lartigue, NOAA Office of Oceanic and Atmospheric Research

PROJECT 09-NGI-06: TOWARD AN UNDERSTANDING OF GULF COAST RESIDENT PREFERENCES AND PERCEPTIONS ON RISK AND RESTORATION

1. Project Leads:

Name	*Title*	*Affiliation*	*Email*
Daniel Petrolia	Lead	Mississippi State University	Drp95@msstate.edu
Keith Coble	Collaborator	Mississippi State University	coble@agecon.msstate.edu

2. All Non-Student Personnel funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Michael Hidrue	Postdoctoral Research Associate	PhD	100%	No
Matthew Interis	Assistant Professor	PhD	8.3%	No
Craig Landry	Assistant Professor (East Carolina University)	PhD	8.3%	No
Daniel Petrolia	Assistant Professor	PhD	12.5%	No

3. All Students funded by this project:

Name	*Category (i.e., highest degree already obtained: BS, MS, PhD)*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Gwan-seon Kim	Research Assistant	BS	50%	No
Jihyun Lee	Research Assistant	BS	100%	No

4. Project Abstract:

The behavior of coastal residents and the economic choices they make profoundly affects coastal land management and the consequences of weather events such as hurricanes and climate change. Federal, state, and local officials must deal with private decisions by individuals to live in coastal zones, build at-risk structures, and whether they evacuate when notified of approaching storms. Lusk and Coble (2005) have pointed out that economic decisions about risk are fundamentally driven by risk preferences and by risk perceptions. However, many coastal decisions such as buying coastal property, investing in storm protection, or supporting public projects such as coastal restoration and invasive species management, which have long-term consequences, also involve a significant time dimension as well. That is, significant time lags may occur between investment and return.

With regard to public projects such as coastal restoration or invasive species management, the economic benefits of management options are not well-understood, and at the same time, the costs are significant. Furthermore, low-lying coastal regions along the Gulf Coast are at greater risk of losses due to the potential of increased sea-level rise stemming from climate change and subsidence. Thus, policy support and behavior may be closely linked to the issue of climate change. How individuals perceive climate change and its potential effects can thus have a profound impact on what projects are supported and to what degree. Thus, although one may support restoration in general, given the added perceived risks from climate change, perhaps with drastic consequences, one may view restoration at pointless in the face of overwhelming opposition.

5. Key Scientific Questions/Technical Issues:

The objectives of this proposed work can be summarized into three specific tasks to be undertaken: 1) an economic analysis of risk preferences and perceptions of coastal residents and how these preferences and perceptions affect behavior, 2) an analysis of public preferences for coastal restoration policies, particularly in Louisiana, and 3) an analysis of recreationists' preferences for improved aquatic invasive species management, particularly in Mississippi.

The results of this work will provide useful insights into whether seemingly anomalous coastal risk taking behavior can be explained by more robust behavioral models. Policy makers and scientist concerned with coastal management will obtain clarification of whether coastal resident behavior is driven by a lack of information, misguided perceptions, or simply personal preferences. Additionally, this work will allow for identification of perceived benefits from restoration and how individuals prioritize them. Finally, it may allow for identification of incentives that can be used to induce socially-optimal behavior.

Additionally, the proposed project will contribute to current state of knowledge in the field of economics by extending and improving how economists model risk preferences and perceptions to explain behavior. Additionally, the research carried out will improve economists' understanding of if and how valuation methods can be improved by better accounting for individual perceptions and other drives of behavior.

6. Collaborators/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. Collaborator is Rex Caffey (Prof, Agricultural Economics)

Name of collaborating organization: Natural Hazards Research Center, East Carolina University

Date collaborating established: Jan. 2009

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 risk analysis of coastal residents. Collaborator is Craig Landry (Assoc. Prof., Dept. of Economics, Interim Director, NHRC)

7. Project Duration:

October 2009 – September 2011

8. Project Baselines:

Contributions to specific NOAA Goals/Objectives:

In addition to the NGI themes, this proposal seeks to fulfill two key foci of the NGI during this second phase of research: collaboration with other institutions and research that contributes to the priorities of NOAA and the Gulf of Mexico Alliance. In general, this work will provide a socio-economic perspective in support of NOAA's Ecosystem mission goal to protect, restore, and manage use of coastal and ocean resources through ecosystem-based management. Specific to NOAA's Five-Year Research Plan, this work will contribute directly to the 3-5 Year Milestones to achieve "at least [a] 25% increase in NOAA's applied…social science research capacity to support increased research focus on social, cultural, and policy aspects of ecosystem-based approaches to management. To a lesser degree, this work will contribute to other objectives and milestones of the Five-Year Plan: "Identify, map, and evaluate existing and restorable habitat and key habitat function;" "Increase number of invasive species populations eradicated, contained, or mitigated;" "Increase number and use of climate products and services to enhance public and private sector decision making."

Contributions to regional problems and priorities: How is the project tied to regional issues and priorities? Identify priority stakeholders, e.g., Gulf of Mexico Alliance, specific user groups.

Additionally, as emphasized in the NGI Year 4 Call for Proposals, this work will support two of the Gulf of Mexico Alliance II Draft Action Items: H-2 (address specific policy and scientific issues regarding habitat conservation and restoration) and R-1/R-3 (risk and resilience assessment/management). Finally, this research will aid in satisfying the need for more socioeconomic research in the Gulf region, as evidenced by the priorities identified in the Gulf of Mexico Research Planning surveys and workshops (Sempier 2009).

Gaps: Describe how the project has narrowed gaps in regional knowledge, data, model performance, geographic coverage, etc.

This research will provide useful insights into whether seemingly anomalous coastal risk-taking behavior can be explained by more robust behavioral models. Policy makers and scientist concerned with coastal management will obtain clarification of whether coastal resident behavior is driven by a lack of information, misguided perceptions, perverse incentives attributable to existing policies, or simply personal preferences. Additionally, this work will allow for identification of perceived benefits from restoration and how individuals prioritize them. Finally, it may allow for identification of incentives that can be used to induce socially-optimal behavior.

The proposed project will contribute to current state of knowledge in the field of economics by extending and improving how economists model risk preferences and perceptions to explain behavior. Additionally, the research carried out will improve economists' understanding of if and how valuation methods can be improved by better accounting for individual perceptions and other drives of behavior.

9. Objectives/Milestones accomplished in this period

Risk Preferences/Perceptions Analysis: Survey instrument design phase: almost complete (on time).

Coastal Restoration Analysis: Literature review: in progress; Survey instrument design phase: ongoing (on time)

Recreational Preferences analysis: Literature review: in progress (on time)

10. Significant research results, protocols developed, and research transitions

No results to date.

11. Outreach activities

No outreach activities to date.

12. Peer Reviewed Articles

No articles to date.

13. Non-refereed articles and reports for this project

No reports to date.

14. Conference presentations and poster presentations for this project

Petrolia, Daniel R. Keith H. Coble, Craig E. Landry, and Matthew G. Interis. "Toward an Understanding of Gulf Coast Resident Preferences and Perceptions on Risk and Restoration." Oral presentation, NGI Annual Meeting, Mobile, AL, May 18-20, 2010.

Petrolia, Daniel R. Keith H. Coble, Craig E. Landry, and Matthew G. Interis. "Toward an Understanding of Gulf Coast Resident Preferences and Perceptions on Risk and Restoration." Poster, NGI Annual Meeting, Mobile, AL, May 18-20, 2010.

15. Personnel from this project hired by NOAA during this reporting period:

None

16. NOAA Sponsor and NOAA Office the primary technical contact:

Julien Lartigue, NOAA Office of Oceanic and Atmospheric Research

PROJECT 09-NGI-07: FOOD WEBS WITHOUT BORDERS: A CASE FOR ECOSYSTEM-BASED MANAGEMENT IN THE NORTHERN GULF OF MEXICO

1. Project Leads:

Name	*Title*	*Affiliation*	*Email*
John Valentine	PI	Dauphin Island Sea Lab	jvalentine@disl.org
Behzad Mortazavi	Co-PI	Dauphin Island Sea Lab	bmortazavi@ua.edu
Lawrence Rozas	Co-PI	NOAA Fisheries Service	Lawrence.Rozas@noaa.gov

2. All Non-Student Personnel funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Lawrence Rozas	PI	PhD	7%	EHCFC, Lafayette, LA
Shawn Hillen	Contract Employee	BS	44%	Galveston Lab
Juan Salas	Contract Employee	BS	40%	Galveston Lab
John Valentine	Project Lead	PhD	0%	No
Behzad Mortazavi	Co-PI	PhD	8%	No

3. All Students funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Jennifer Atchison	BS	MS	25%	Galveston Lab
LaTina Steele	BS	Ph.D	100%	No
Anthony Vedral	BS	MS	100%	No
Taylor Kauffman			100%	No
Kristen Gloekler			100%	No

4. Project Abstract:

The importance of food web interactions at the interface among terrestrial, aquatic and marine ecosystems is poorly understood within coastal areas of northern Gulf of Mexico. Among the issues which require detailed examination is the quantification of the strength of food web linkages among these ecosystems. Another issue is the determination of the productivity of estuaries in the region and the fate of the extraordinary primary production that characterizes these ecosystems. The intensity of interactions between estuarine-dependent marine fishes and crustaceans, resident aquatic predators and prey, and terrestrial predators are likely to be extraordinary. We suggest that it will be difficult to make management decisions that will result in the wise stewardship of ecosystems in coastal areas of the northern Gulf of Mexico because we, and our salient regulatory agencies, have not yet incorporated such trophic interactions in regional management plans.

A two-year course of study was designed to assess the importance of: 1) energetic and nutrient subsidies from vegetated habitats in the Mobile Bay Delta and surrounding terrestrial habitats to the productivity of the base of the Mobile Bay food web and 2) migratory fishes and crustaceans in supporting the growth of higher order consumers living in the oligohaline reaches of this system. We use diverse methodologies including stable isotopic analyses, sampling and experimental evaluations to attack these applied and theoretically interesting questions.

5. Key Scientific Questions/Technical Issues:

The specific objectives of this project are to: 1) increase formal and informal educators' and students' understanding of the interconnectedness of these ecosystems as well as the principles and importance of ecosystem-based management, 2) elevate the understanding of future science educators about the importance of research to future members of society and environmental management via the emersion of graduate student education science majors in the research activities of our laboratories as summer interns, 3) elevate resource managers and regulatory authorities understanding about the importance of ecosystems-based management 4) train future scientists about NOAA's research mission via graduate assistantships, and 5) educate the public, management and regulatory community about the need to develop and enforce plans that incorporate the principles of ecosystem-based management in the northern Gulf of Mexico via public presentations and peer-reviewed scientific publications.

6. Collaborators/Partners:

Name of collaborating organization: NOAA Fisheries Service

Date collaborating established: Oct 2009

Does partner provide monetary support to project? Amount of support? None

Does partner provide non-monetary (in-kind) support? Short description of collaboration/partnership relationship: Drs. Rozas (NOAA) and Valentine (DISL) work in concert to conduct sampling, stomach analyses and manipulative field experiments while Mortazavi (DISL) and Valentine collaborate on the isotopic analyses. Each will participate actively in report and publication generation. Dr. Miller-Way, the head of Discovery Hall at DISL leads the effort on outreach and takes part in the recruitment of graduate student science major interns.

7. Project Duration:

Oct 2009 to Oct 2011

8. Project Baselines:

Contributions to specific NOAA Goals/Objectives:

This study elucidates the strength of cross-habitat trophic linkages between deltaic, estuarine and terrestrial ecosystems. It will also serve to disseminate the understanding gained from our efforts to those who would benefit - current and future educators, students, resource managers and regulatory authorities. It should be noted that our activities address both goals of NOAA's Education Strategic Plan (2008): Environmental Literacy and Workforce development.

Contributions to regional problems and priorities:

This study provides environmental managers throughout the Gulf of Mexico with sound scientific data that supports the adoption of ecosystem-based management practices for the wise stewardship of estuaries in the northern Gulf of Mexico. To date, few studies have made such practices a centerpiece of their environmental management.

How the project has narrowed gaps in regional knowledge, data, model performance, geographic coverage, etc.

As data are still being collected, gaps that our results will fill have not yet been determined.

9. Objectives/Milestones accomplished in this period

A total of 72 nekton samples and 72 benthic cores were collected each season (fall= October 13-15, 2009; spring=May 11-13, 2010) in the Mobile-Tensaw Delta. Samples were taken each season at randomly selected sites in marsh vegetation (24), submerged aquatic vegetation (24), and shallow nonvegetated bottom (24). The stem density of marsh vegetation, salinity, water temperature, dissolved oxygen concentration, turbidity, water depth, and distance to marsh edge were measured at each sample site, and water level was continuously recorded from nearby tide gauges. All of the nekton samples from the October 2009 field trip have been sorted and the animals from 58 of these samples were identified to species. Thirty-four of the nekton samples from the May 2010 field trip have been sorted thus far.

Over 125 plant and animal species were collected for isotopic analysis in the Mobile-Tensaw Delta from April 1, 2010 through June 16, 2010. An additional 40 animal (vertebrate and invertebrate) species were collected for isotopic analysis in and around Mobile Bay from May 1, 2010 through June 14, 2010. A further 15 plant and animal species were collected from Dauphin Island on June 17, 2010 in order to compare the isotopic signatures of terrestrial and freshwater species grown near saline vs. freshwater conditions. All plants and animals were identified to species. The plant tissue was freeze dried and ground in preparation for isotopic analysis. Gut contents of several fish were identified and recorded, and macroinvertebrate and fish tissues were prepared for isotopic analysis.

10. Significant research results, protocols developed, and research transitions

As data are still being collected, results have not yet been determined.

11. Outreach activities

No outreach activities to report.

12. Peer Reviewed Articles

None

13. Non-refereed articles and reports for this project

None

14. Conference presentations and poster presentations for this project

None

15. Personnel from this project hired by NOAA during this reporting period:

None

16. NOAA Sponsor and NOAA Office the primary technical contact:

Julien Lartigue, NOAA Office of Oceanic and Atmospheric Research

PROJECT 09-NGI-08: UNDERSTANDING COASTAL RESILIENCY FROM HURRICANE IMPACTS USING INTEGRATED MODELING AND OBSERVATIONS

1. Project Leads:

Name	*Title*	*Affiliation*	*Email*
Q. Jim Chen	PI	Louisiana State University	qchen@lsu.edu
Robert Twilley	Co-PI	Louisiana State University	rtwilley@lsu.edu
Jaye E. Cable	Co-PI	Louisiana State University	jcable@lsu.edu
Pat Fitzpatrick	Co-PI	Mississippi State University	fitz@gri.msstate.edu
Hendrick Tolman	Co-PI	NOAA-NCEP-EMC	Hendrik.Tolman@noaa.gov

2. All Non-Student Personnel funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Q. Jim Chen	PI	PhD	0	No
Haihong Zhao	Post-doc	PhD	50%	No
Kelin Hu	Post-doc	PhD	50%	No
Robert Twilley	Co-PI	PhD	0	No
Jaye E. Cable	Co-PI	PhD	6%	No
Pat Fitzpatrick	Co-PI	PhD	15%	No
Chris Hill	Research Associate	MS	25%	No
Yee Lau	Research Associate	MS	80%	No
Haldun Karan	Research Associate	PhD	50%	No
Hendrick Tolman	Co-PI	PhD	0	Yes, NOAA-NCEP-EMC
Arun Chawla	Research staff	PhD	16%	Yes, NOAA-NCEP-EMC

3. All Students funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Kim Marsh	BS	MS	100%	No

4. Project Abstract:

Within the United States, the northern Gulf of Mexico is particularly susceptible to the impacts of frequent tropical storms and hurricanes due to its tropical/subtropical location and its unique bathymetric, geometric, and landscape features. Coastal wetlands provide many services to the ecosystem; most importantly, they provide a line of defense for coastal communities against hurricane impacts. Marshes and forested wetlands of sufficient area can reduce wind, wave and surge energy, which reduces the damaging effects of hurricanes on coastal infrastructure and communities. As coastal wetlands were lost to erosion and sea level rise over the last century, a critical function of storm attenuation was reduced concomitantly.

A number of river diversion projects designed to restore coastal wetlands have been built in south Louisiana. Among them are the Caernarvon Fresh Water Diversion Project in upper Breton Sound east of the Mississippi River and the Wax Lake Outlet of the Atchafalaya Basin in St. Mary Parish, LA. These diversions represent two scales and types of land building restoration models: One is the nourishment model that puts fresh water and accompanying sediment in existing older marsh landscapes, and; the second is a land creation model that builds new land with vegetation in new deltaic lobes using river

sediments. Both systems may have different resiliencies from hurricane impacts, and consequently, they provide an important comparison and contrast for storm surge and wave reduction models.

The long term goal of this study is to improve our understanding of coastal resiliency from hurricane impacts using integrated numerical modeling, in-situ observations and remote sensing techniques. The specific objectives of this two-year project are to 1) Develop a comprehensive dataset of vegetation, soil and salinity characteristics before and after high energy disturbances in Breton Sound and Wax Lake Delta based on in-situ monitoring; 2) Compile geospatial data and analyze wetland changes in Breton Sound and Wax Lake Delta based on satellite imagery and modeling; 3) Improve the wind forcing input for storm surge and wave models; 4) Extend the NOAA ocean wave prediction model to coastal regions with wetlands; 5) Develop and test a coupled wave, surge and sediment transport modeling system for coastal regions using the Breton Sound and Wax Lake Delta as a natural “laboratory”; 6) Conduct numerical simulations to test hypotheses of coastal resiliency.

An interdisciplinary and multi-institutional (LSU, MSU and NOAA) research team has been assembled to address the scientific questions identified in the proposal. Because of the complexity of the problems, we propose a novel and comprehensive approach, which integrates advanced computer models using high performance computing technologies, an array of in-situ observations and various remote sensing platforms.

Coastal landscapes represent some of the most impacted and altered ecosystems worldwide, are sensitive to coastal hazards, and also represent the highest projected concentration of population growth. The resiliency of coastal communities depends on the resiliency of coastal marshes and forests that are an important component of ecosystems and an integral part of hurricane protection. Thus, the proposed study is critical to the success of coastal restoration and hurricane protection in the northern Gulf of Mexico and beyond.

5. Key Scientific Questions/Technical Issues:

In order to understand, quantify and predict coastal resiliency from hurricane impacts, we have identified a number of key scientific equations: 1) What are the controlling factors dictating wetland erosion or sedimentation during a hurricane? 2) Can our predictive ability for assessing storm surge damage be improved through the development of coupled wave, surge, and sediment transport models? 3) How does the wetland loss contribute to the increase of storm surge and waves in coastal basins? 4) What is the rate of recovery of a damaged wetland after a storm? 5) Which land building restoration model is more effective and resilient from hurricane impacts?

6. Collaborators/Partners:

Name of collaborating organization: National Center for Earth Surface Dynamics (NCED)

Date collaborating established: Jul 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: Provides the project with access to the database of Wax Lake Delta.

Name of collaborating organization: University of Notre Dame

Date collaborating established: Jul 2009

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: Provides the project with access to the new ADCIRC mesh.

7. Project Duration:

Nov 2009 – Oct 2011

8. Project Baselines:

Contributions to specific NOAA Goals/Objectives:

The long term goal of this study is to improve our understanding of coastal resiliency from hurricane impacts using integrated numerical modeling and in-situ observations and remote sensing techniques within an interdisciplinary and multiple-institutional approach. This is in line with the NGI Research Themes (i.e. Coastal Hazards, Climate Change and Climate Variability Effects on Regional Ecosystems), the Sea Grant highest ranked research areas for the Gulf of Mexico (i.e. Sea Level Change, Subsidence and Storm Surge), and the NOAA's 5- and 20- year research plans (i.e. Forecasting the Ecological Effects of Sea Level Rise and Climate Change, Severe Storms).

Contributions to regional problems and priorities:

"Wetland and Coastal Conservation and Restoration" is one of the five prioritized issues of regional significance identified by the Gulf of Mexico Alliance (GOMA).

How the project has narrowed gaps in regional knowledge, data, model performance, geographic coverage, etc.

The understanding of the hurricane impact on coastal wetlands in Louisiana has been significantly improved by the numerical modeling and satellite data analysis conducted by the project team.

9. Objectives/Milestones accomplished in this period

The following is a list of milestones achieved during Year 1. Details are provided in Section 10.

Milestone A: Developed and analyzed a Landsat 5 database of Breton Sound wetland before and after Hurricane Katrina (2005) and Gustav (2008). The impact of the Caernarvon Diversion has also been studied.

Milestone B: Wind forcing algorithms for storm surge and wind wave simulations

Milestone C: Modeling storm surge generated by Hurricane Gustav

Milestone D: Modeling coastal waves generated by Hurricane Gustav

Milestone E: Hydrodynamics across vegetated marsh surfaces

Milestone F: Skill assessments of sediment transport models using coupled wave-surge model

10. Significant research results, protocols developed, and research transitions

Milestone A: Wetland change database of hurricane impact on Breton Sound wetlands

Background

One tool for countering Louisiana's wetland erosion is river diversions. Diversions are designed to infuse freshwater into existing wetlands with limited sediment, while others are land-building projects. Among them are the Caernarvon Fresh Water Diversion Project in upper Breton Sound east of the Mississippi River, which is a nourishment project opened in 1992 designed to alter salinity conditions. Caernarvon dramatically changed the nearby land characteristics, increasing freshwater marsh plant coverage near the diversion, and growing intermediate marsh plants in the formerly brackish areas.

However, the altered landscape may not be resilient to hurricane storm surge. One area that experienced serious damage was the Delacroix region, particularly in the fresh and intermediate marsh regions near the Caernarvon. The damage consisted of expanded ponds; compressed, rolled, or inverted marsh; scoured and denuded marsh; and shoreline erosion. The goal of this research is to quantify the marsh degradation near the diversion, in the intermediate marsh, the outer marsh, and the marsh north of the MRGO. This analysis is performed for pre-Katrina/Rita, pre-Katrina/Rita, and post-Gustav/Ike using data from NOAA's Coastal Change Analysis Program (C-CAP) program [distributed by the Coastal Services Center], and from the Landsat 5 Thematic Mapper (TM) satellite sensor.

Methodology

The C-CAP program provides a nationally standardized database on land cover and habitat change, typically in 5-year cycles starting in 1996. A special dataset was also developed for pre- and post-Katrina. Because no C-CAP data was available post-Gustav, MSU developed a methodology to investigate this storm's impact on Delacroix and Hopedale using Landsat 5 TM images. Details of the methodology are in the NGI poster (Fitzpatrick et al. 2010).

However, producing a single composite dataset from multiple Landsat images is difficult. Pixel brightness values for wetland classification schemes are affected by seasonal and annual phenological vegetation cycles; cloud coverage and cloud shadows; tide stage; water levels; sun angle; calibration issues; earth/sun distance; atmospheric conditions, and sun/target/sensor geometry (phase angle). Therefore, our approach consisted of qualitative quality control to remove datasets with excessive cloud coverage. The data is then subsetted into 11 Areas of Interest, and statistical significance tests are calculated for water coverage change before and after Katrina and Gustav using a Wilcoxon rank-sum test. The significance is then assessed through a *p* value.

Results

The C-CAP data showed that the largest erosion rates from 1996-2005 (before Katrina) occurred near the diversion with values of 14.5% and 20.9%, respectively. Other areas experienced erosion of 1-8%. Katrina caused erosion throughout the region, but the biggest proportional changes are in the diversion area, with water coverage increasing from 14% to 40-50%.The intermediate marsh suffered degradation as well but not as large with, changing from 56% to 68% water coverage. Other regions range from 3-11% water coverage increase due to Katrina's impact.

The MSU methodology showed similar results. Because the data contains scatter some regional values are different than C-CAP, the statistical significance tests assessed wetland coverage change. Wilcoxon tests showed statistically significant changes to all regions after Katrina at a very convincing level. For Gustav, the largest water percentage occurred near the diversion and have the smallest p-values An example of Landsat land-water classification is shown in the top right figures for Pre-Katrina and Post-Gustav are included in this report. Note the increased open water and marsh shearing patterns near the diversion region from both hurricanes.

These results suggest that the current Caernarvon implementation for land restoration may be flawed since it does not consider hurricane impacts. We hypothesize that the freshwater species composition hasn't become diverse enough, and currently consists of mostly floating species instead of rooted plants. These reasons are still under investigation.

Milestone B: Wind forcing algorithm development for storm surge and wind wave simulations

During the two-year period of this study, we will be developing several wind datasets for Katrina, Gustav, and Ike, and performing sensitivity test forcing of the ADCIRC model. These wind datasets will include sequentially interpolated H*Winds, a Holland wind profile based on the MSU algorithm, and a 1-km WRF dataset based on a data assimilation scheme. The wind fields will be contrasted, and the sensitivity of the ADCIRC runs to the different wind forcing examined through validation against high water marks and USGS portable gauges.

In Year 1, we have finished the Holland wind profile scheme, and development of the interpolated H*Winds scheme is underway. The WRF work was postponed until the release of the Hurricane WRF model in March 2010. An MSU staff member (Chris Hill) attended the "EMC/MMM/DTC Joint WRF Tutorial for Hurricanes" from February 24, 26, 2010. Chris then presented these class notes to MSU staff in March 2010. In addition, a new data assimilation scheme called GSI will be released this summer, and another staff member will be attending that workshop in June 2010. Development of a high-resolution HWRF dataset is now underway. In addition, Yee Lau and Pat Fitzpatrick attended the ADCIRC Workshop (April 20-21, 2010) followed by an ADCIRC Boot Camp (April 22-23, 2010), so that MSU will be current on the latest research and software developments of the storm surge model.

Alongside the MSU's development, the LSU team has developed an improved asymmetric hurricane wind model. The results have been documented into a journal manuscript submitted for publication in March, 2010. The model creates a two-dimensional surface wind field based on National Hurricane Center (NHC) forecast (or observed) hurricane wind point values, namely the maximum wind, radius of maximum wind, the specified (34, 50, and 64-knot) wind intensities and their radii in 4 quadrants. Three major improvements have been made to the existing model in order to retain the consistency between the (observed or forecast) input parameters and the model output, and to better resolve the asymmetric structure of a hurricane. The existing model ignored the Coriolis parameter and imposed a range restriction on shape parameter B. It is found that the former can lead to an error in the maximum wind speed greater than 20% for weak but large tropical cyclones. Therefore, the first improvement is made by including the Coriolis effect and removing the range restriction on B. Second, the effect of the translation velocity of a hurricane is excluded from the forecast (or observed) wind intensities before applying the Holland vortex (which is based on vortex-relative winds only) to avoid exaggeration of the wind asymmetry. The translation velocity is added back in at the very end of the new procedure. Third, a new method has been introduced to develop a weighted composite wind field that makes full use of all wind parameters (i.e. not just the largest available specified wind intensity and its radii) given in the hurricane forecast. An idealized hurricane and two historical hurricanes have been used to test the model. It is found that the improved parametric model leads to better agreement with field observation in comparison to existing parametric models, which will result in better predictions of hurricane waves and storm surges.

Milestone C: Modeling storm surge generated by Hurricane Gustav

Hurricane Gustav (2008) is good test case for the fully-coupled storm surge and hurricane wave models (Dietrich et al. 2009) because of the availability of high quality nearshore wave and surge observations. On an identical, unstructured mesh, the new version of SWAN for waves and ADCIRC for storm surge is tightly coupled through the exchange of water levels, currents and radiation stresses. An improved asymmetric hurricane wind model integrated with gulf-scale background winds was employed to generate wind fields. A large number of field observations, including winds, waves and water levels, were collected for model verification. Comparisons with field observations show that the model results generally agree well with the measurements. Further numerical experiments are carried out to quantify the influence of coastal landscapes. The effects of water level and currents on waves, and conversely, the effects of radiation stress on storm surge are studied quantitatively. Results were presented at the NGI annual conference in May, 2010 and at the State of the Louisiana Coast conference in June, 2010.

Milestone D: Modeling Coastal Waves Generated by Hurricane Gustav

The NCEP team has developed coastal meshes for the projects sites based on the bathymetric data provided by LSU. ADCIRC results of Hurricane Gustav are ready to be linked to the NOAA ocean wave model extended to the coastal areas. Testing of the model against field measurements are being carried out, including 12 NOAA wave buoys in the Gulf of Mexico and 20 nearshore wave gages deployed by the University of Notre Dame. All the field data have been compiled and analyzed in comparison with wave simulations using other models by the LSU team.

Milestone E: Hydrodynamics across vegetated marsh surfaces

Background

Constraints on our understanding of storm surges and coastal resiliency include quantification of vegetation characteristics into simple resistance parameters, such as Manning’s roughness coefficients. Vegetation reduces local bed stress and contributes to sediment retention along a flow path. As vegetation density increases, the turbulent stress within the flow field is reduced, and subsequently, suspended sediment concentrations decrease. The vegetation acts not only as a dampening effect due to its density, but also the width and orientation of blades can influence turbulent stress in the system. Our estimates of land-building capacity in a deltaic system are distorted by the lack of quantitiative information regarding the role of marsh vegetation in sediment and hydrodynamics.

Methodology

We are measuring vegetation characteristics at nine stations within a deltaic marsh system consisting of fresh, brackish, and salt marshes in Breton Sound Basin, which bore the brunt of the 2005 Hurricane Katrina storm surge as well as the recent impacts from Hurricanes Gustav and Ike (2008). Sampling sites were determined from aerial images of vegetation distributions and field reconnaissance trips. Temporary piezometers will be installed at a representative station of the fresh and brackish stations in the next 4 weeks. The salt water station piezometer has been installed. These piezometers will each have a pressure, temperature, conductivity transducer to monitor pore water levels and salinity through time in response to storm surges. Additional stations will be incorporated through participation in a summer REU research program at Wax Lake Outlet Delta.

At each field site, two water samples are collected at each site for suspended sediment concentrations prior to vegetation and sediment sampling. A short, small diameter sediment core is collected for sediment physical properties (e.g. bulk density, porosity, organic matter content, shallow descriptive stratigraphy). Other measurements are surface water salinity, a transect of marsh flow velocities from the channel across the station, and water depth at each velocity measurement. Fifteen plants of each species are randomly selected for plant bending properties, stem diameter, and plant height within a 3 m X 3 m station area. Bending properties of each plant are taken as the measured force (N) needed to bend the plant stem at mid-height to a 45^o angle. Spring scales and an electronic gauge (i.e. Pasco Scientific) are used. Plant density is also measured within a pvc quadrangle at two locations for each station. Pre-storm sampling is in progress and is expected to be completed by the end of July. Follow-up collections of the same measurements after storm season has passed will be completed between November 2010 and April 2011.

Results

Plant stiffness, height and diameter were measured at a salt marsh station in Breton Sound, Louisiana (N29°39.870', W089°36.611). Plant diversity was low, with only two salt tolerant species found at this site, *Spartina alterniflora* and *Juncus roemerianus* (Table 4). The site was accessed via a 30-m long boardwalk from the channel into the marsh and then we walked over the marsh surface 17 m further to our station. Standing water was not present on the marsh surface, but salinity in the adjacent channel was 3.1 due to the high Caernarvon diversion flow to the estuary over the spring season. Diversion flow was extended into June to help alleviate the spread of oil into the basin as it creeped from the Gulf of Mexico north. Channel currents were about 0.12 m/sec at 20 cm below the surface. Other salt marsh sites are characterized by plants typical of brackish environments (Table 5) and results for these stations are still being analyzed.

Table 4. Preliminary results of biophysical measurements (n = 15 plants/species) for salt marsh sites in Breton Sound, Louisiana.

Parameter	***Spartina alterniflora***			***Juncus roemerianus***		
	Mean	**Stdev**	**%cv**	**Mean**	**Stdev**	**%cv**
Plant Height (cm)	25.67	3.98	15.5	90.4	11.1	12.3
Plant Diameter ($^H/_2$, mm)	7.41	0.85	11.4	1.99	0.32	15.9
Plant Stiffness (45^o; N/m^2)	2.04	0.54	26.5	0.21	0.07	36.4

Table 5. Plant species and common names for other salt marsh stations.

Site	**Botanical name**	**Common Name**
Salt (2S)	*Iva frutescens*	High-tide bush/Marsh elder
Salt (2S)	*Heliotropium curassavicum*	Seaside heliotrope
Salt (3S)	*Scirpus robustus*	Salt marsh bulrush
Salt (3S)	*Distichlis spicata*	Salt grass/Spike grass
Salt (3S)	*Spartina patens*	Salt meadow cordgrass

Milestone F: Skill assessments of sediment transport models using coupled wave-surge model

Background

The spatial and temporal scales of wetland-related processes vary greatly, depending on the forcing agents. Although the time scale of the coastal processes driven by the high energy events of tropical cyclones is short, it has been recognized that hurricanes are the major driving force of morphological changes in this micro-tide, low wave energy environment. Hurricanes Katrina and Rita (2005) came ashore on the Louisiana coast and devastated the state and beyond. Comparing the LANDSAT Thematic Mapper (TM) satellite imagery acquired pre- and post the landfalls of the two hurricanes, Barras (2006) estimated that 562 km^2 of coastal wetlands were converted to open water. Hurricane Katrina caused about 106 km^2 of wetland loss in the upper Breton Sound alone. By contrast, Turner et al. (2006) have reported that storm surges resulted in substantial sedimentation that could benefit coastal wetlands. Reliable simulation of sediment erosion, transport, and deposition during a storm event would disclose the fate of sediments and provide guidance to the restoration and protection of this vanishing coast.

Methodology

Quantifying and predicting sediment dynamics in the mixed or heterogeneous sedimentary environment with vegetation during extreme wind events are challenging. With the rapid development of computer technology, significant advances in modeling storm surges and surface waves have been made, which allows for coupling a spectral wave prediction model (e.g., SWAN) and a three-dimensional (3D) estuarine circulation model (e.g., POM) with an improved sediment transport model (SED) to investigate sediment erosion, transport, and deposition in response to Hurricane Katrina.

The objective of the study is to develop a computer modeling system that is able to predict storm surges, hurricane waves and corresponding wetland erosion in Breton Sound, east of Mississippi River. The spatial and temporal variations of water levels, 3D currents and wind waves are hindcasted. An improved sediment transport model (Zhao 2009) is linked to the hydrodynamic models through the flow fields and bottom shear stresses of combined waves and currents with vegetation effects. We use the integrated models as a tool to quantify the volume of marshlands and cohesive sediments scoured by the currents and waves generated by Hurricane Katrina, and to simulate the fate of those suspended sediments.

Results

The computational domain covers the area from the Mississippi River bird-foot delta on the southwest to Gulf Shores, Alabama on the northeast, including Lake Pontchartrain, Breton Sound and Mobile Bay. A new curvilinear grid is developed to better resolve the topography and geometry of the complex coastline and marshlands of Breton Sound. Both 3D storm surge model and unsteady spectral wave model use the same curvilinear mesh, eliminating interpolation errors of mapping information from a triangular mesh to a rectangular mesh commonly used in the coupled surge and wave modeling. The effects of vegetation on storm surge and wind waves are taken into account by using increased Manning's coefficients in both models according to the vegetation types provided by the National Wetland Research Center. The influences of storm surge on the wind waves are taken into account by updating the water depths and current fields in the unsteady SWAN model every 15 minutes based on the output from the 3D storm surge model that has eight topography-following layers in the vertical direction. A wetting and drying scheme has been implemented into the 3D hydrodynamic model that covers the upland to 10 m above the mean sea level. The effects of waves on the surge include the enhanced bottom shear stresses due to the presence of surface waves. The regional-scale coupled storm surge and wave models provide the offshore boundary conditions and wind forcing for the present 3D surge and wave models.

Testing of the coupled wave and 3D surge models against measured high watermarks along the coast as well as wave heights and wave periods near the north end of Chandeleur Island shows fairly good agreement. A fully nonlinear boundary layer model for wave and current interaction provides the bottom shear stresses for the sediment transport model. Emphasis has been given to the influences of vegetation on the hydrodynamic forcing and critical shear stress in the 3D sediment transport model, including the vegetation-induced momentum and energy dissipation in both wave and surge models, the sheltering effect when the vegetation height is several times greater than the particle excursion near the bottom due to the wave motion, and the strong vertical variation of critical shear stresses on the marsh lands. We are the first to simulate the spatial variation of the maximum bottom shear stresses during Hurricane Katrina. The model result indicates that the Caernarvon Marsh in the upper Breton Sound experienced larger bottom shear stresses than did its neighboring Biloxi Marsh to the east. This explains the greater wetland loss in the Caernarvon Marsh area as observed in the numerical model and satellite imagery. Quantitative comparisons of the modeled and observed erosion volumes are being carried out and field verification of the vertical variation of the critical shear stress are planned in conjunction with numerical experiments. Results were presented at the NGI annual conference in May, 2010 and at the State of the Louisiana Coast conference in June, 2010.

11. Outreach activities

Fitzpatrick videotaped an interview with 78-year old Buddy Melerine, a life-long commercial fisherman in Delacroix, and his grandson Philip Mones, also a fisherman. Philip took Fitzpatrick on a boat tour of the wetlands, including a close-up of the diversion, and described how the wetlands have changed and eroded during his lifetime. We are working on a documentary which will be uploaded on Fitzpatrick's website. Fitzpatrick was interviewed by Channel 15 in Greenville, MS (WXVT) Friday, June 18. Topics include the upcoming hurricane season and the impact of a hurricane's interaction with the oil spill.

In response to Gulf of Mexico Oil Spill, Robert Twilley and Q. Jim Chen at LSU have served on the Science and Engineering Review Team (SERT) assembled by the Louisiana Office of coastal Protection and Restoration (OCPR). The modeling results from this project were disseminated to the state agency related to wave and surge modeling for the construction of the sand berms along the Louisiana coast and their possible impacts.

12. Peer Reviewed Articles

None

13. Non-refereed articles and reports for this project

None

14. Conference presentations and poster presentations for this project

- Chen, Q., Zhao, H., Hu, K., Twilley, R. R., and Cable, J. E., 2010. An integrated storm surge, hurricane waves, salinity and sediment transport modeling system for Breton Sound, LA. NGI Annual Conference, Mobile, AL. May 18-20.

- Hu, K., Chawla, A., Chen, Q., Tolman, H., and Fitzpatrick, P., 2010. Coupling of ADCIRC and WAVEWATCH for Northern Gulf Coast. NGI Annual Conference, Mobile, AL, May 18-20.

- Hu, K., Chen, Q., Westerink, J. J., Dietrich, J. C., and Kennedy, A. B, 2010. Testing of fully-coupled storm surge and wave models for coastal Louisiana. The State of the Coast Conference, Baton Rouge, LA, June 8-10.

- Zhao, H., Chen, Q., Pardue, J., Willson, C., and Twilley, R., 2010. Numerical modeling of hydrodynamics and wetland loss in Breton Sound, Louisiana. The State of the Coast Conference, Baton Rouge, LA, June 8-10.

- Fitzpatrick, P. J., and Y. Lau, 2010. Myths about the cause of Hurricane Katrina's storm surge. School of Science and Engineering, Spring Seminar Series, Tulane University, Feb. 26, New Orleans, LA, [invited]

- Fitzpatrick, P. J., Y. Lau, C. M. Hill, T. V. Wamsley, B. Jelley, and E. Valenti, 2010. Myths about the cause of Hurricane Katrina's storm surge. 29th Conference on Hurricanes and Tropical Meteorology, May 10-14, Tuscon, AZ.

- Fitzpatrick, P. J., S. Bhate, Y. Lau, V. Anantharaj, and S. Shean, 2010. Wetland erosion in Delacroix and Hopedale from hurricanes this decade and the impact of the Caernarvon freshwater diversion. 4th Annual Northern Gulf Institute Conference, May 18-20, Mobile, AL.

15. Personnel from this project hired by NOAA during this reporting period:

None

16. NOAA Sponsor and NOAA Office the primary technical contact:

Julien Lartigue, NOAA Office of Oceanic and Atmospheric Research

PROJECT 09-NGI-09: VISUAL ANALYTICS FOR ASSESSMENT AND INTERPRETATION OF SIMULATED RIVER FLOODING

1. Project Leads:

Name	*Title*	*Affiliation*	*Email*
Philip Amburn, Ph.D.	PI	Mississippi State University	amburn@gri.msstate.edu
Robert Moorhead, Ph.D.	Co-PI	Mississippi State University	rjm@gri.msstate.edu
Jamie Dyer, Ph.D.	Co-PI	Mississippi State University	jd381@msstate.edu

2. All Non-Student Personnel funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Philip Amburn	PI	PhD	20%	No
Robert Moorhead	Co-PI	PhD	10%	No
Jamie Dyer	Co-PI	PhD	15%	No
Derek Irby	RA	BS	30%	No
John van der Zwaag	RA	BS	30%	No
David Reed	Hydrologist in Charge	MS	0%	No (LMRFC)
David Welch	Development and Operations Hydrologist	MS	0%	No (LMRFC)
Jeff Graschel	Service Coordination Hydrologist	MS	0%	No (LMRFC)

3. All Students funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Jibonananda Sanyal	MS	PhD	50%	No

4. Project Abstract:

The specific goals of this project are the development of visual analytic tools to enable scientists and forecasters to better interpret and distribute hydrologic information. The resulting product will be useful in the research community as an interpretation tool for river level and flood data, but would also serve as a useful platform for hydrologic forecasters within the NWS to more quickly and accurately determine areas at risk for flooding. Another potential use is communicating with the emergency management community to better visualize areas to be impacted by flooding and support making decisions on evacuations. These tools will allow NOAA river forecasters to better visualize the extent of flooding, increasing their knowledge and understanding of the extent and effects of flooding. These tools will allow forecasters to relay more information to the emergency management community while issuing forecasts to help protect life and property. Images may be provided to the emergency managers and local officials to assist in making the decision to evacuate people.

5. Key Scientific Questions/Technical Issues:

The key scientific and technical issues are these:

What visualization techniques will best represent the output of the HEC-RAS model output to professional forecasters? When should 2D representations be used and when should 3D be used?

What visualization techniques best represent forecast information to the general public and to emergency responders? When should 2D be used and when should 3D be used?

What are the software engineering issues and approaches to use for the construction of this software environment? What can be done to make this extensible, reliable, and user friendly?

We need to integrate this software package into the NWS Community Hydrologic Prediction System (CHPS) system. What is the best way to incorporate the results of this effort into CHPS to affect the forecaster's operational work flow?

6. Collaborators/Partners:

Name of collaborating organization: Lower Mississippi River Forecast Center (National Weather Service)

Date collaborating established: Winter, 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: To date, LMRFC personnel have written a Concept of Operations document, put us in touch with the developers of CHPS, written use cases helping to refine the requirements of the software, and have been involved in face-to-face and web-based conference meetings throughout the project.

7. Project Duration:

Oct 2009 – Oct 2011

8. Project Baselines:

Contributions to specific NOAA Goals/Objectives:

NOAA Goal 3. The mission of the NOAA Hydrology Program is to issue river and flood forecasts and warnings to mitigate the loss of life and property and support the nation's economy. An integral part of this mission is the NWS River Forecast Centers (RFC) who model important portions of the hydrologic cycle. The importance of the RFCs and the NOAA Hydrologic Services Program were recognized in the NOAA Strategic Plan for 2009-2014 with two of the goals directly related to this program. The two goals that the NOAA Hydrologic Services Program and the RFCs directly support are the water and weather goal to serve society's need for weather and water information and the commerce and transportation goal to support the nation's commerce with information for safe, efficient, and environmentally sound transportation. This project will support these two goals.

The proposed tools will allow NOAA river forecasters to better visualize the extent of flooding, increasing their knowledge and understanding of the extent and effects of flooding. These tools will allow forecasters to relay more information to the emergency management community while issuing forecasts to help protect life and property. Images may be provided to the emergency managers and local officials to assist in making the decision to evacuate people. These tools clearly support NOAA's mission and goals.

Contributions to regional problems and priorities:

Part of the charter for the NWS RFCs is to work with local and regional managers. In May 2010 we met with Mr. Hiram Boone of the Pat Harrison Waterway District in MS. The Pascagoula River is part of the district, and he expressed interest in the upcoming visualization capabilities. Mr. Reed of LMRFC wants to be involved in these interactions.

How the project has narrowed gaps in regional knowledge, data, model performance, geographic coverage, etc.

Visualization of the HEC-RAS model data and its application to emergency management, watershed planning is at the heart of this effort. We are anxious to provide some value added to the interaction and communication between professional forecasters at RFCs and local organizations.

9. Objectives/Milestones accomplished in this period

Software development is well underway. There are four software releases planned for calendar year 2010. The first release has occurred, and work on second release is well underway. At the end of the fourth release we plan to have a test version of the software ready and will install it for testing at LMRFC.

10. Significant research results, protocols developed, and research transitions

Calendar year 2010 is devoted to initial software development. Research transition will occur in calendar year 2011.

11. Outreach activities

PIs presented results at conferences and worked with NGI outreach program to develop project materials.

12. Peer Reviewed Articles

None

13. Non-refereed articles and reports for this project

None

14. Conference presentations and poster presentations for this project

Amburn, Philip; Dyer, Jamie; Graschel, Jeff; Irby, Derek; Moorhead, Robert; Ramirez, David, Reed, David, Sanyal, Jibonananda; Welch, David, Zhang, Song; van der Zwaag, John; *FloodViz: Visual Analytics for Assessment and Interpretation of Simulated River Flooding*, NGI Annual Meeting, Mobile, AL, May 18-20, 2010

Sanyal, Jibonananda; Amburn, Philip; Irby, Derek; van der Zwaag, John; Zhang, Song; Moorhead, Robert; *Level of Detail for Terrain Rendering*, NGI Annual Meeting, Mobile, AL, May 18-20, 2010

15. Personnel from this project hired by NOAA during this reporting period:

None

16. NOAA Sponsor and NOAA Office the primary technical contact:

Julien Lartigue, NOAA Office of Oceanic and Atmospheric Research

PROJECT 09-NGI-10: CLIMATE-RELATED ICHTHYOFAUNAL SHIFTS IN THE NORTHERN GULF OF MEXICO: IMPLICATIONS FOR ESTUARINE ECOLOGY AND NEARSHORE FISHERIES

1. Project Leads:

Name	*Title*	*Affiliation*	*Email*
Kenneth L. Heck, Jr	Lead PI	Dauphin Island Sea Lab	kheck@disl.org
Joel Fodrie	Co-PI	University of North Carolina	jfodrie@unc.edu
Gillmore (Butch) Pellegrin	NOAA Lead PI	NOAA-NMFS	Gilmore.Pellegrin@noaa.gov
Kim Johnson	NOAA co-PI	NOAA-NMFS	Kim.A. Johnson@noaa.gov

2. All Non-Student Personnel funded by this project:

None

3. All Students funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Joseph Myers	BS	MS	50	No

4. Project Abstract:

Global temperatures are rising, and should produce a poleward shift in the distribution of many marine species. Recently, Fodrie et al. (2010) quantified changes in fish assemblages within seagrass meadows of the northern Gulf of Mexico (GOM) between the 1970s and 2000s, and observed changes consistent with this forecast. Specifically, multiple species of snappers (Lutjanidae) and parrotfishes (Scaridae) were either added to the local ichthyofauna, or have become notably more abundant over the last 3+ decades. For instance, Fodrie et al. (2010) reported that *Lutjanus synagris* (lane snapper) were entirely absent throughout the 1970s, but were the 8th most abundant seagrass-associated fish caught during the 2000s. Additionally, *Ocyurus chrysurus* (yellowtail snapper) *Sparisoma viride* (stoplight parrotfish), *Sparisoma radians* (bucktooth parrotfish) and *Cryptotomus roseus* (bluelip parrotfish) were all absent in the 1970s but are now collected in northern GOM seagrasses. *Lutjanus griseus* (gray snapper; having increased in relative abundance by 105-fold, and now the 7th most abundant species), and *Nicholsina usta* (emerald parrotfish; having increased in relative abundance by 22-fold, and now the 23rd most abundant species) are other tropical/subtropical representatives that now constitute a greater percentage of the seagrass-associated fishes in the northern GOM.

A key next step is to determine how these “new” tropical/subtropical species are interacting with endemic species. That is, what are the consequences, if any, for estuarine ecology and regional fishery production? To predict the ultimate consequences of these climate-related changes, we must explore basic questions regarding species interactions and food-web ecology. To this end, we propose experiments on YOY snappers (examining interactions with other seagrass-associated fishes) and parrotfishes (examining herbivory on seagrasses) that may be having an increasingly profound effect in the northern GOM.

Seagrasses are critical nursery habitat for many recreationally/commercially prized species (e.g., *Mycteroperca microlepis*, gag grouper, and *Cynoscion nebulosus*, speckled trout), and information is needed to determine how climate change is affecting seagrass-derived fishery production. Therefore, we also propose to compile observational data that will allow us to forecast whether “new” tropical/subtropical species such as juvenile *L. griseus* and *L. synagris* are enhancing or diminishing the overall nursery role

of local seagrasses. For this, we plan to use NOAA SEAMAP data, as well as field surveys within seagrass meadows, to explore the spatial and temporal relationships in juvenile (seagrass-associated) and subadult (offshore) abundances of fishes (particularly *L. griseus* and *L. synagris*) and evaluate the role that regional warming may be playing in altering seagrass-derived fishery production in the northern GOM.

In proposing this work, our goal is to provide researchers and managers with information that will be required for implementing ecosystem-based conservation measures in the northern GOM as regional/global climate continues to evolve.

5. Key Scientific Questions/Technical Issues:

Our primary goal is to provide researchers and managers with information that will be required for implementing ecosystem-based conservation measures in the northern GOM as regional/global climate continues to evolve. To do so we will accomplish the following:

I. SEAMAP data will be synthesized to explore decadal-scale changes in offshore communities. As it reflects global warming, we expect to see a significant increase over time in the abundance of *L. griseus* and *L. synagris*, and potentially *M. microlepis* and *E. morio,* since they have increased in abundance in local seagrass meadows over the last 3+ decades.

II. Seagrass-meadow surveys conducted throughout this project will be compared to the datasets generated by Livingston (1985) and Fodrie et al. (2010) to evaluate the trajectory of seagrass-associated fish communities. During these surveys, we expect to collect multiple species of snappers (Lutjanidae; ≥ 3 species), groupers (Serranidae; ≥ 7 species), and parrotfishes (Scaridae; ≥ 4 species) – families that are typically dominant at lower latitudes (Sedberry & Carter 1993, Thayer *et al.* 1999, Acosta *et al.* 2007). The presence of these fishes will support the conclusions made by Fodrie et al. (2010) of an extension of tropical conditions poleward in the northern GOM. Furthermore, seagrass surveys throughout the 2000s will be compared to available SEMAP data to investigate the temporal relationship between offshore and nearshore (seagrass) abundances of *L. griseus* and *L. synagris*.

III. We will provide NGI with information on the following: a) *L. griseus*, *L. synagris,* and endemic species growth rates for all treatments in which we manipulated community composition or diversity and excluded a predator, and b) *L. griseus*, *L. synagris,* and endemic species survivorship rates for treatments in which we manipulated community composition or diversity and included a predator. While we may or may not see notable diversity effects, we do expect to observe significant species “identity” effects. This is to say, for example, interactions between snappers and *L. rhomboides* will likely produce different growth and survivorship outcomes for fishes than interactions between snappers and other, less common endemics.

IV. We will provide NGI with estimates of seagrass grazing effects per individual *N. usta* and other herbivorous species. Based on previous reports (Unsworth *et al.* 2007), we expect seasonally (summer/fall) high (0.1–10x daily seagrass growth) grazing rates from parrotfishes.

6. Collaborators/Partners:

Name of collaborating organization: NOAA NMFS Pascagoula Laboratory

Date collaborating established: Spring 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: We will examine all data generated throughout the life of the Southeast Monitoring and Assessment Program (SEAMAP) within Region 11, an area stretching E-W from Mobile Bay Inlet, AL, to the Mississippi River Outflow, LA, and N-S from nearshore environments out to the 50-m isobath. This will involve data synthesis and analysis in a collaboration between researchers at the Dauphin Island Sea Lab (DISL), UNC and co-PIs Pellegrin and Johnson at the NOAA Laboratory in Pascagoula, MS.

7. Project Duration:

Oct 1, 2010 – Sep 30, 2011

8. Project Baselines:

Contributions to specific NOAA Goals/Objectives:

NGI Theme and NOAA Goal: Theme #3, Climate change and climate variability effects on regional ecosystems; Strategic Goal #2.

Contributions to regional problems and priorities:

Our primary goal is to provide researchers and managers with information that will be required for implementing ecosystem-based conservation measures in the northern GOM as regional/global climate continues to evolve.

How the project has narrowed gaps in regional knowledge, data, model performance, geographic coverage, etc.

The project is still in its data gathering phase.

9. Objectives/Milestones accomplished in this period

1) We've submitted a letter to Butch Pelligren (our NOAA lead) requesting the relevant trawl data from SEAMAP Region 11.

2) Trawl surveys of all but 3 of the areas to be sampled for snapper/grouper/parrotfish have been accomplished during May-June 2010.

10. Significant research results, protocols developed, and research transitions

None available yet

11. Outreach activities

Co-PI Fodrie presented our NGI project during a panel discussion at National Marine Sanctuary Program's Capitol Hill Ocean Week in June 2010. The panel title(s) were: "Clean Energy and a Healthy Ocean: Navigating the Future" / "Today's Energy Mix: Impacts on Ocean and Coastal Resources".

12. Peer Reviewed Articles

Fodrie, FJ, KL Heck Jr, SP Powers, WM Graham and K Robinson (2010) Climate-related, decadal-scale assemblage changes of seagrass-associated fishes in the northern Gulf of Mexico. Global Change Biology 16: 48-59.

13. Non-refereed articles and reports for this project

None

14. Conference presentations and poster presentations for this project

None

15. Personnel from this project hired by NOAA during this reporting period:

None

16. NOAA Sponsor and NOAA Office the primary technical contact:

Julien Lartigue, NOAA Office of Oceanic and Atmospheric Research

PROJECT 09-NGI-11: IDENTIFYING LINKAGES BETWEEN ZOOPLANKTON DYNAMICS, FISHERY RESOURCES AND CLIMATE CHANGE IN THE NORTHERN GULF OF MEXICO

1. Project Leads:

Name	*Title*	*Affiliation*	*Email*
Joanne Lyczkowski-Shultz	Project Lead	National Marine Fisheries Service	Joanne.Lyczkowski-Shultz@noaa.gov
Sara E. LeCroy	Lead Investigator	University of Southern Mississippi	sara.lecroy@usm.edu
Malinda Sutor	Lead Investigator	Louisiana State University	msutor1@lsu.edu
William (Monty) Graham	Lead Investigator	Dauphin Island Sea Lab	mgraham@disl.org

2. All Non-Student Personnel funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
K. Marancik	Research Associate	MS	100	Yes, NEFSC, Narragansett, RI
S. LeCroy	Lead Investigator	MS	8	No
M. Sutor	Lead Investigator	PhD	25	No
W. Graham	Lead Investigator	PhD	8.33	No
H. Perry	Co-PI	MS	2	No
K. VanderKooy	Technician	MS	50	No
G. Sanchez	Research Associate	PhD	36	No
F. Hernandez	Co-PI	PhD	8.33	No
M. Benfield	Co-PI	PhD	11.11	No

3. All Students funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
A. Millett	BS	MS	100	No
C. Knight	BS	MS	100	No

4. Project Abstract:

This project brings together regional plankton and fisheries expertise along with new technologies and methodologies to expand a unique database by incorporating data on the hitherto neglected invertebrate zooplankton component of SEAMAP plankton samples and to improve the SEAMAP plankton sampling program. The combined efforts will result in the application of new imaging technologies to analyze and archive SEAMAP plankton samples; improvement in taxonomic resolution of invertebrate zooplankton in those samples; and integration of new (to SEAMAP) methodologies for underway zooplankton sampling and the enumeration of gelatinous zooplankton. Digitization of zooplankton using Zooscan technology will enable SEAMAP to exploit the enormous potential information remaining in the samples. We anticipate that our examination of decapod crustacean larvae will result in identification of specimens to lower taxonomic levels than had been previously achievable. These efforts will culminate in a more extensive and inclusive plankton database that will become the foundation not only for our investigations into zooplankton dynamics but for complementary studies of ecosystem function and assessments requiring long-term databases. Together we will assemble and summarize relevant environmental and climate

data, and undertake analytical steps necessary to identify linkages between abundance of target species of larval fish, zooplankton abundance and composition, and climatic and physical factors in the northern Gulf of Mexico.

5. Key Scientific Questions/Technical Issues:

The key scientific question addressed by our research is how to fully utilize and protect the great storehouse of data, information and knowledge present in the historical (since 1982) and ever-growing in number SEAMAP plankton samples. The invertebrate zooplankton component of SEAMAP plankton samples represents a great untapped resource that can yield invaluable insights into the functioning of the Gulf of Mexico ecosystem, potentially proving critical to the future management and sustainability of Gulf fisheries. Marine scientists and resource managers currently recognize the need for data from all functional levels of ecosystems to understand both the immediate and long-term effects of changes within ocean basins and to assess ecosystem health. Furthermore, it is not too far-fetched to speculate that a ‘zooplankton index’ might prove to be a useful explanatory variable in future fishery stock assessment models. By combining such zooplankton indices with regional climatic cycle data, we may be able to move toward a mechanistic understanding of why changes occur in zooplankton communities over time.

The key technical issue our project addresses is how to decrease the time required to extract information on invertebrate (and vertebrate) plankton from SEAMAP samples. The process of sorting, identifying, and enumerating organisms from plankton samples is both time and labor intensive. Application of modern technologies to reduce the time it takes to extract critical information from plankton samples has become an imperative research focus. The RAPID Initiative (Research on Automated Plankton Identification), a global collaboration of scientists from the machine vision, software and hardware development, and biological oceanography communities is one such effort. The goal of RAPID is to facilitate and advance the use of automated identification of zooplankton imaged from preserved and in-situ imaging systems. Part of RAPID is the development of taxonomically-validated training sets. Such sets would consist of digitized images of organisms whose identities are known with a high degree of confidence. SEAMAP is an ideal example of a program that can provide such samples using the subset of samples that are currently being sorted and identified. We plan to build training sets made up of these digitized images with colleagues around the world via the RAPID website (http://www.scor-wg130.net). Digitization of zooplankton using Zooscan technology will enable SEAMAP to exploit the potentially enormous amount of hitherto neglected information in the samples. Furthermore, archiving of the digitized images of SEAMAP plankton samples will insure that this invaluable record of zooplankton communities will be available for future analyses.

6. Collaborators/Partners:

Name of collaborating organization: Sea Fisheries Institute, Plankton Sorting and Identification Center (ZSIOP)

Date collaborating established: 1982

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: It is not surprising that an important cooperative research linkage exists between our project and ZSIOP. Samples sorted for ichthyoplankton that have been archived in Poland will be returned to the U.S. so that information on the invertebrate zooplankton fraction can be used in ecosystem assessments and analyses of response to climate change. The results of our collaborative work, in particular, improved taxonomic resolution of select taxa of invertebrate zooplankton, will permit ZSIOP scientists to more accurately and precisely identify decapod crustacean larvae in Gulf of Mexico plankton samples at such time when routine analysis of SEAMAP samples for the larvae of exploited shellfish can be initiated by SEFSC/SEAMAP.

Name of collaborating organization: Texas A&M University

Date collaborating established: 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: The researchers at LSU have established a collaboration with other NOAA funded researchers at Texas A&M to examine the physical (CTD) and biological (zooplankton) data from the SEAMAP program in the context of enhancing our understanding of the mechanisms that form and create hypoxia in the Gulf of Mexico. This project will enhance that collaboration and allow us to increase the number of SEAMAP zooplankton samples that will be digitally archived and analyzed which will increase the amount of biological information available to examine biologically-mediated phenomena such as hypoxia.

7. Project Duration:

Jul 1, 2009 – Jun 30, 2011

8. Project Baselines:

In this first year of our two-year project we have begun contributing to two of NOAA's Strategic Goals and associated objectives, Ecosystems and Climate. As with all broad scale, data-rich ecological studies a full accounting of contributions cannot be made until all data is collected and analyzed. Also the full contribution or benefit of certain objectives will only be realized over the long term; when, for example, improved resolution of decapod crustacean identification will yield more precise data on abundance and life history of commercial shrimp and crabs resulting in more effective management strategies. This resulting information will fill a gap in regional knowledge of the early life history and population dynamics of commercial decapod crustaceans. A major stakeholder that will directly benefit from this knowledge is the Gulf of Mexico Fishery Management Council whose responsibility it is to effectively manage fishery populations and their habitats in the Gulf.

The results of our combined research activities have begun to insure that the historical record of SEAMAP plankton data will be accessible for evaluation of how the composition of zooplankton assemblages in coastal waters may be used as indicators of ecosystem health throughout the Gulf of Mexico. This is of keen interest to the Gulf of Mexico Alliance whose responsibility it is to safeguard the ecological and economic health of the Gulf. We and other future researchers will finally be able to examine this amassed historical record and determine how variability in invertebrate zooplankton assemblage structure can be used as a metric in integrated ecosystem assessments for the Gulf.

Our project places a heavy emphasis on graduate student participation in all aspects of this research from seagoing sampling activities to laboratory examination of specimens, to the analysis of data, manuscript writing and oral presentations. With our emphasis on a holistic view of Gulf of Mexico planktonic assemblages (i.e. both vertebrate and invertebrate components) we will be instilling ecosystem management principles in the scientists, teachers, community leaders and resource managers of the future. Two graduate students are currently involved with our project. One, Andy Millett, will receive his MS degree in Marine Science from the University of South Alabama/Dauphin Island Sea Lab in August 2010. His research study focused on delineating zooplankton community structure in the northern Gulf and its relationship to large gelatinous zooplankton, specifically the moon jellyfish. The data for his research was collected from a NOAA research vessel with the continuous underway fish egg sampler (CUFES) during SEAMAP plankton surveys. The second student, Carley Knight, recently (January 2010) began her studies at University of Southern Mississippi/Gulf Coast Research Laboratory. Her research will focus on aspects of the ecology of zooplankton in the northern Gulf.

Although the Gulf of Mexico ecosystem is not specifically mentioned in the milestones under this performance objective, the need for understanding the impacts of climate variability and change on the Gulf of Mexico ecosystem is no less important than in the Bering Sea or California Current region. The data generated from our analyses of plankton assemblages will advance understanding of how this foundation component of all marine ecosystems responds to the effects of global scale, as well as, localized events here in the Gulf of Mexico. The uniqueness of the Gulf in physiography, e.g. the Gulf basin varies relatively little in latitude but extensively over longitude (unlike other major large marine ecosystems), makes the insights of how the Gulf ecosystem functions especially useful in comparisons across the diverse range of earth's ecosystems. We have begun examining what the potential responses of zooplankton to climatic signals may be and have found that climate-related hydrological regimes in the northern GOM are linked to maximum and average displacement volumes of zooplankton as measured from SEAMAP plankton samples over the historical record of the program.

9. Objectives/Milestones accomplished in this period

1. Complete inventory of SEAMAP plankton samples recovered and lost due to Katrina at the SEAMAP Invertebrate Plankton Archiving Center (SIPAC). (7/31/10) **GCRL/SIPAC, NMFS**

Post-Katrina inventory of the SIPAC unsorted plankton holdings has been completed (4896 of 9010 pre-Katrina archived samples recovered [54%]).

2. Arrange shipment of select SEAMAP plankton samples back to the U.S. from ZSIOP (Sea Fisheries Institute, Gdynia, Poland, Plankton Sorting and Identification Center) in order to fill gaps in SIPAC holdings caused by Katrina. (Two shipments: 4/30/10 and 4/30/11) **NMFS**

A complete and final inventory of the SEAMAP samples still held in Poland was assembled in both spreadsheet and database formats. Unfortunately, there are far fewer samples remaining in the Polish Archive then was previously thought. The first shipment of Katrina 'replacement' samples (n = 1,992) from Poland to the US has been arranged and is on its way with arrival expected 1 August 2010.

3. Assemble an electronic image database of archived SEAMAP plankton samples using Zooscan and begin analyses of zooplankton assemblages. (7/31/11-digitization complete, 10/31/11- selected analysis complete) **LSU**, **GCRL/SIPAC, NMFS**

Recovered samples (aliquots) for the years 1982-1986 (649 samples) have been transferred to LSU for scanning. Scanning of samples has begun.

4. Assemble/summarize data on decapod crustacean larvae previously identified from SEAMAP samples at GCRL. (7/31/10) **GCRL/SIPAC**

Post-Katrina inventory of the SIPAC identified zooplankton holdings is nearing completion and a total of 3606 of 6419 archived samples (56%) was recovered. These previously identified larval decapod and cephalopod samples have been inventoried and spreadsheets of this material are currently being checked against spreadsheets of pre-Katrina holdings to determine percent recovery for each taxonomic category. In some cases, additional samples that were not in the original spreadsheets were encountered and these are being incorporated into the archive. In addition, several of the higher taxonomic groupings reported in the poster presented at the May NGI Annual Meeting have been broken down further and are being re-tabulated. For example, the "Sicyoniidae mixed stages" category has been broken down to include "Sicyoniidae larvae" and "Sicyoniidae postlarvae". Progress to date is indicated in Table 6.

Table 6. Post-Katrina percent recovery for identified invertebrate zooplankton samples archived at the SEAMAP Invertebrate Plankton Archiving Center.

Taxon	# Samples Recovered and Inventoried at GCRL	# Samples Archived at GCRL Prior to Hurricane Katrina	# Samples Not in Pre-Katrina Spreadsheet	% Recovered
Farfantepenaeus aztecus postlarvae	66	125	0	52.8%
Farfantepenaeus duorarum postlarvae	18	28	0	64.3%
Litopenaeus setiferus postlarvae	17	31	0	54.8%
Trachypenaeus sp. postlarvae	15	27	0	55.6%
Sicyoniidae larvae	168	293	25	48.8%
Sicyoniidae postlarvae	24	45	2	48.9%
Menippe zoea	54	90	5	54.4%
Phyllosoma larvae	98	181	7	50.3%
Penaeidae larvae	392	656		
Penaeidae postlarvae	195	601		
Menippe megalopae	61	94		
Callinectes similis megalopae	362	708		
Callinectes sapidus megalopae	448	841		
Other Decapoda	260	257		
"Penaeus" sp.	34			
Misc. Penaeidae	1			
Menippe unstaged	1			
Misc. Decapoda	44			
Portunus spp.	In Progress			
Portunidae zoeae	In Progress			
Portunidae megalopae	In Progress			
Non-portunid crabs	In Progress			
Cephalopoda juveniles	In Progress			

Green	Inventory completed; verified with existing spreadsheets.
Blue	Inventory completed; currently being verified with existing spreadsheets.
Pink	Inventory completed; searching for data location in existing spreadsheets
Yellow	Currently being inventoried

5. Verify and improve resolution (as feasible) of larval decapod crustacean identifications. (1/31/11, starting 8/1/10 – verification; 1/31/12, starting 2/1/11 – improve resolution) **GCRL/SIPAC, NMFS**

Milestone to begin in Year 2

6. Direct additional zooplankton analysis of SEAMAP plankton samples at ZSIOP from select SEAMAP surveys to complete temporal and spatial survey coverage for decapod crustacean early life stages. (1/31/12, starting 8/1/10) **NMFS**

Project funds were directed to the Sea Fishery Institute Plankton Sorting and Identification Center (ZSIOP) for additional zooplankton analysis of SEAMAP plankton samples from select SEAMAP surveys to complete temporal and spatial survey coverage for decapod crustacean early life stages. Over 500 SEAMAP plankton samples were analyzed for zooplankton at the Sea Fishery Institute Plankton Sorting and Identification Center (ZSIOP) and an additional 660 samples were agreed to be analyzed during the current Joint Studies Agreement year (May 2010 – April 2011).

7. Incorporate invertebrate zooplankton data into the NMFS SEAMAP Oracle database and develop a GIS platform for the visualization and integration of data on the early life stages of both exploited and non-exploited fishes and invertebrates. (7/31/11) **NMFS**

Statistical and mapping software packages were purchased by Mississippi Labs to develop a GIS platform for the visualization and integration of data on the early life stages of both exploited and non-exploited fishes and invertebrates. Entry of zooplankton data from identifications conducted at ZSIOP was begun.

8. Assemble a reference series of invertebrate zooplankton specimens from SEAMAP samples for development of zooplankton 'identification' software and subsequent analysis of scanned images of SEAMAP plankton samples. (1/31/12, starting 8/1/10) **GCRL/SIPAC, LSU**, **NMFS**

Milestone to begin in Year 2

9. Undertake analyses of zooplankton and fish eggs in CUFES (continuous underway fish egg sampler) samples taken during recent SEAMAP plankton Gulfwide surveys; evaluate results of these collections. (7/31/10) **DISL, NMFS**

Major equipment purchased by Mississippi Labs included a Continuous Underway Fish Egg Sampler (CUFES) which will be used to gather samples of zooplankton and fish eggs during upcoming SEAMAP plankton Gulfwide surveys.

Processing and data analysis have been completed for two Gulf-wide CUFES surveys (fall 2008 and 2009). These data constitute a large portion of the Masters thesis of A. Millett.

10. Establish observational & sampling protocols for gelatinous zooplankton collection during SEAMAP surveys; implement these and evaluate results of data collected during surveys in 2009 – 2011. (7/31/10) **DISL, NMFS**

Protocols for gelatinous plankton identification and collection were established for the fall 2009 SEAMAP plankton cruise. The data were analyzed and constitute a large portion of the Masters thesis of A. Millett.

11. Enhance student participation and involvement in SEAMAP resource surveys while augmenting graduate student training in the field of marine plankton. (1/31/12, starting 2/1/10) **DISL, LSU**, **GCRL/SIPAC/CFRD, NMFS**

One, Andy Millett, will receive his MS degree in Marine Science from the University of South Alabama/Dauphin Island Sea Lab in August 2010. His research focused on delineating zooplankton community structure in the northern Gulf and the potential influence of large gelatinous zooplankton (specifically the moon jellyfish) on zooplankton communities. The data for his research was collected from a NOAA research vessel with the continuous underway fish egg sampler (CUFES) during SEAMAP plankton surveys.

The second student, Carley Knight, recently began her studies at University of Southern Mississippi/Gulf Coast Research Laboratory. Her research will focus on aspects of the ecology of zooplankton in the northern Gulf.

To date, DISL graduate students (A. Millett and R. Shiplett) have participated on SEAMAP plankton cruises. Both students received U. of South Alabama graduate credit by enrolling in Oceanographic Experiences, a course designed to give students credit for real-world experience on lengthy oceanographic cruises. Both students were required to prepare cruise plans and provide syntheses of activities and findings.

12. Identify sources, assemble and summarize relevant environmental and climate data, and undertake analytical steps to identify linkages between abundance of target species of larval fish, zooplankton abundance and composition, and climatic and physical factors in the northern Gulf of Mexico. (1/31/12) **LSU**, **GCRL/CFRD, DISL, NMFS**

Select responses of zooplankton to climatic signals were explored and analyzed. Climate-related hydrological regimes from the north-central Gulf of Mexico were linked to maximum and average displacement volumes of zooplankton in the northern GOM.

10. Significant research results, protocols developed, and research transitions

Surface zooplankton communities were analyzed for two, Fall SEAMAP Gulfwide plankton surveys (2007 & 2008). These data were collected using the Continuous Underway Fish Egg Sampler (CUFES). Multivariate analyses showed that main drivers of large separation of communities between east and west of the Mississippi River, and on and off the continental shelf were chlorophyll fluorescence and salinity (as well as distance from shore). These data suggest that bottom-up processes rather than top-down predation were likely responsible for community patterns in the northern Gulf of Mexico (Figure 55).

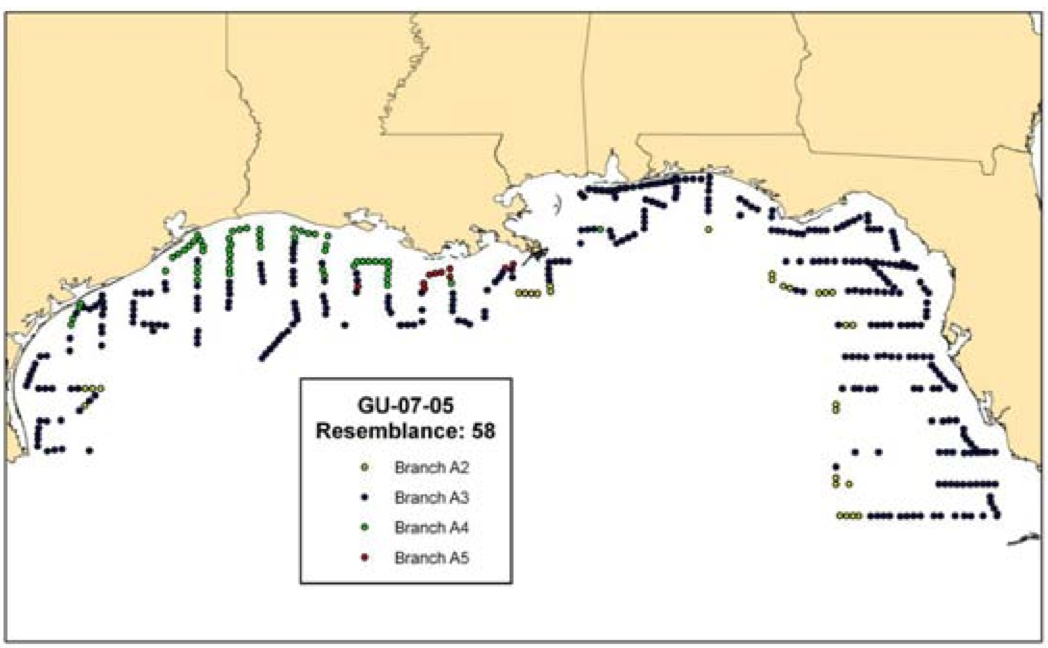


Figure 55. Spatial distribution of major zooplankton communities as measured using a CUFES

We compared displacement volumes of SEAMAP plankton samples under opposite climate-related hydrological regimes. Displacement volumes varied widely and when all samples were considered, there was no significant difference between the two regimes. There was however, a difference in the extreme

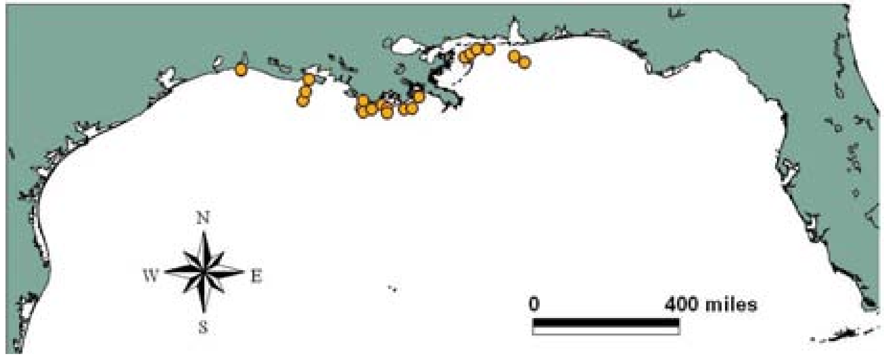


Figure 56. Extremely high displacement values of zooplankton (3.833 - 31 ml/m3; yellow circles) were only found during the climate-related hydrological regime associated with high river flows (Atlantic Multidecadal Oscillation cold/North Atlantic Oscillation positive phase: 1982-1994) in the northcentral Gulf of Mexico.

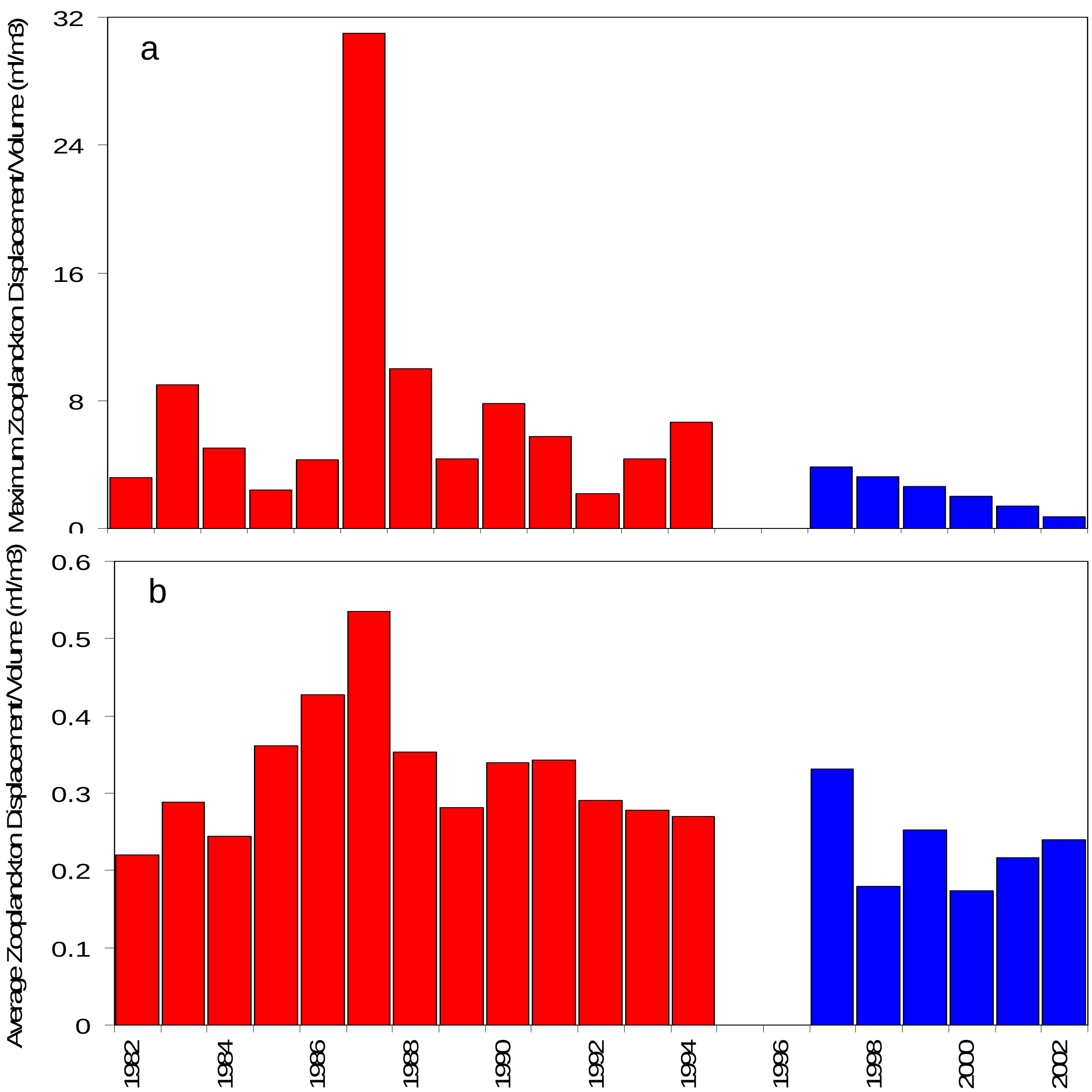


Figure 57. Annual maximum (a) and average (b) displacement values of zooplankton were usually higher during years of high river flow regime (Atlantic Multidecadal Oscillation cold/North Atlantic Oscillation positive phase, red bars) than during years of low river flow regime (Atlantic Multidecadal Oscillation warm/North Atlantic Oscillation negative phase, blue bars).

displacement volume values between the two regimes (Figure 56). Further examination of the data showed that maximum and average zooplankton displacement volumes were related to climate river flow regimes (Figure 57).

11. Outreach activities

None to report

12. Peer Reviewed Articles

None to report

13. Non-refereed articles and reports for this project

None to report

14. Conference presentations and poster presentations for this project

Sutor, M., M. Benfield, K. Loeffler, A. Armas. Digital Plankton: Archiving, Serving, and Analyzing the SEAMAP Zooplankton Time Series. Presented at the NGI Annual conference May 2010, Mobile, AL

Sutor, M., J. Lyczkowski-Shultz, M. Benfield, S. LeCroy, H. Perry, W. Graham, F. Hernandez. The Missing Link: A Regional Academic and NOAA Partnership to Examine the Connection between Climate Change and Fisheries Dynamics in the Gulf of Mexico. Presented at the NGI Annual conference May 2010, Mobile, AL

Sanchez-Rubio, G., Perry, H.M., and Lyczkowski-Shultz, J. Comparison of Displacement Volumes of Zooplankton under Different Climate-related Hydrological Regimes in the Northern Gulf of Mexico. Presented at the NGI Annual conference May 2010, Mobile, AL (poster)

Millett, A., W. Graham, F. Hernandez, G. Zapfe, and J. Lyczkowski-Shultz. Zooplankton Community Structure in the Northern Gulf of Mexico: Implications for Ecosystem Management. Presented at the NGI Annual conference May 2010, Mobile, AL.

LeCroy, S.E., K. VanderKooy, Carley Knight and Consuela Cowan. 2010. Post-Katrina recovery of the SEAMAP Invertebrate Plankton Archiving Center (SIPAC) at the Gulf Coast Research Laboratory. NGI Annual conference, May 2010, Mobile, AL (poster)

15. Personnel from this project hired by NOAA during this reporting period:

Mr. Andy Millett was hired by NOAA/NMFS, Pascagoula, MS; effective 29 June 2010.

16. NOAA Sponsor and NOAA Office the primary technical contact:

Julien Lartigue, NOAA Office of Oceanic and Atmospheric Research

PROJECT 09-NGI-12: VALIDATION AND VERIFICATION OF A CANINE FECAL SOURCE IDENTIFICATION

1. Project Leads:

Name	*Title*	*Affiliation*	*Email*
Kelly Goodwin	Lead	NOAA	kelly.goodwin@noaa.gov
Chris Sinigalliano	Lead	NOAA	christopher.sinigalliano@noaa.gov
Shiao Wang	Co-PI	University of Southern Mississippi	shiao.wang@usm.edu

2. All Non-Student Personnel funded by this project:

None

3. All Students funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Melody Pobuda	BS	BS	25%	Yes, SWFSC

4. Project Abstract:

The work aims to validate quantitative source tracking assays to allow transition to NGI and beyond. The quantitative component (versus plus/minus) is important because quantitative assays allow calculation of relative loads. Such information allows managers to prioritize actions and to assess their success. The ultimate goal is to transition field results into outreach and management actions to achieve a reduction in fecal loads. For example, canine fecal pollution represents a “low hanging fruit” with regard to management action in that where this source of pollution is identified modest investments in infrastructure can provide effective remedial action (e.g., providing bags, disposal cans, and trash pickup, education, and limits on dog access). Similarly, remediation actions for fecal contamination from gulls can be undertaken once the contamination is properly identified.

5. Key Scientific Questions/Technical Issues:

Accurate methods of fecal source identification are needed to prescribe remediation strategies, to assess the potential risk of zoonotic pathogens, and for Clean Water Act applications, such as Total Maximum Daily Loads (TMDLs). There is growing concern about health threats from animal fecal contamination. For example, the feces from gulls and dogs can represent significant fecal contributions to coastal waters, beaches, and urban runoff. Feces from these animals can harbor a variety of zoonotic pathogens. Previous studies have used conventional PCR assays to identify gull and dog feces. While such assays can determine the presence or absence of gull or dog fecal pollution, they cannot estimate loadings. This study developed Taqman real-time quantitative PCR (qPCR) assays for dog-host-specific *Bacteroides* in order to identify fecal contamination from canine sources. In addition, a Taqman qPCR assay that was developed for gull-host-specific *Catellicoccus marimammalium* was transitioned to other researchers, including those involved with NGI and GOMA.

6. Collaborators/Partners:

Name of collaborating organization: Dr. Helena Solo-Gabriele and Dr. Lora Fleming, University of Miami NSF/NIEHS Oceans and Human Health Center

Date collaborating established: 2005

Does partner provide monetary support to project? Amount of support? None

Does partner provide non-monetary (in-kind) support? Access and help with sample collection and monetary support includes funding to run the DogBac and Gull assays in OHH Center studies

Short description of collaboration/partnership relationship: They have utilized the Dog-Bac and Gull assays in epidemiology studies.

Name of collaborating organization: Dr. Valerie Harwood, University of South Florida

Date collaborating established: 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: Exchange of protocols, reagents, etc. for both the DogBac and Gull assays. Participates in multi-lab validation of current qPCR protocols.

Name of collaborating organization: Dr. Troy Scott, Source Molecular

Date collaborating established: 2005

Does partner provide monetary support to project? Amount of support? Support for gull marker work

Does partner provide non-monetary (in-kind) support? None

Short description of collaboration/partnership relationship: Helped develop the Gull assay

Name of collaborating organization: Dr. Jorge W. Santo Domingo, US EPA – NRMRL/WSWRD/MCCB

Date collaborating established: 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: Helped develop the preliminary (end-point PCR) version of the Gull Assay, and now participates in multi-lab validation of current Gull Assay qPCR protocols.

Name of collaborating organization: Dr. John F. Griffith, Southern California Coastal Water Research Project

Date collaborating established: 2009

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: Participates in multi-lab validation of current Gull Assay qPCR protocols

7. Project Duration:

Oct 1, 2009 – Nov 1, 2010

8. Project Baselines:

Contributions to specific NOAA Goals/Objectives:

NOAA Goal 1. This research supports NOAA's Ecosystems Mission Goal to protect, restore, and manage use of coastal and ocean resources through Ecosystem Approaches to Management (EAM). Specifically, this research supports the Ecosystems Goal by developing tools and technologies to support integrated ecosystem assessments and to advance understanding of ecosystems to improve resource management. The research will help NOAA achieve the outcome of healthy and productive coastal and marine ecosystems that benefit society. Furthermore, this work maps to the Performance Objectives to increase the number of regional, coastal, and marine ecosystems delineated with approved indicators of ecological health and socioeconomic benefits that are monitored and understood.

This research falls under the following Ecosystem Goal Research Areas:

- support collaborative approaches to science and management at the regional level;
- enhance resilience to hazards (by developing tools and technologies that can be incorporated into, for example, Health Early Warning Systems);
- protect marine and coastal resource integrity and security (from biological threats and emerging disease).

In addition, this project aligns with the NOAA goal of serving society's needs for water information and with the Weather and Water Performance Objective of increasing the development and transition of advanced science and technology to operations and services. This work meets Cross-Cutting Priorities for developing a world-class workforce by producing individuals with a combination of abilities in molecular biology, microbiology, microbial ecology, and oceanography.

Contributions to regional problems and priorities:

The presence of enteric pathogens and animal feces in coastal waters is a major concern along the Gulf Coast. Having reliable and sensitive methods to identify fecal sources is important in efforts to protect the public, devise sound remediation strategies and for Total Maximum Daily Load (TMDL) calculations. This work specifically addresses GOMA Action Plan #2, Section WQ1: Human Disease Draft Actions that call for improved methods to identify areas that are impaired by pathogens and to track sources of the pathogens.

This project stays linked to the priorities of the Gulf of Mexico Alliance (GOMA) through the efforts of the project participants. Dr. Sinigalliano is the federal lead on the GOMA Water Quality Priority Issue Team, and all the PIs/co-PIs are members of the GOMA Pathogens Workgroup. These interactions allow the work to adapt to current needs. Case in point is the assay for gull fecal contamination. Source identification of bird fecal contamination has long been identified as a critical need in the Gulf of Mexico. The assay was developed through external support, and the technology transfer was implemented in part through the connections made through NGI and GOMA, thus helping narrow a gap in the realm of coastal water quality.

9. Objectives/Milestones accomplished in this period

- Extending sampling collection to additional dog beaches
- Extending sample collection to different climate (CA instead of FL)
- Technology transfer of the dog protocol to a 2nd NOAA laboratory (from Miami, FL to La Jolla, CA); this includes training of a technician and extension of protocol to a different type of qPCR instrument.
- Sample collection, membrane filtration, DNA extraction, qPCR, DNA isolation & archival
- Assays field-test against 670 recreational water samples during an epidemiology study conducted in south Florida.

10. Significant research results, protocols developed, and research transitions

- The DogBac protocol was developed. This protocol included development of a Taqman probe to complement previously published primers in order to achieve a real-time quantitative PCR (qPCR) assays for Bacteroides species specific to canine fecal material.
- The DogBac assay was successfully tested with DNA extracts from dog fecal samples collected from a variety of dogs. Ninety per cent (26/29) of individual dog samples tested were positive by the DogBac assay. Seventy-seven per cent (20/26) of dog samples tested were “highly” positive (average = 1.2e7 PE/µl) compared to the other positive samples (average = 2.4e3 PE/µl).
- The DogBac assay was specific, returning high target copy numbers only for dog fecal samples. No samples tested positive from birds, the most common form of wildlife at many urbanized beaches.
- The DogBac assay was use to quantify the contribution of canine-source Bacteroides in bathing waters during an epidemiological study in Miami, FL. A contribution from canine fecal material was observed on two of the days
- The DogBac assay was use to quantify the contribution of canine-source Bacteroides in a water quality study in Little Venice, Florida Keys.
- The DogBac protocol was shared with NGI collaborators.
- The Gull-feces-specific *Catellicoccus marimammalium* qPCR protocol was developed based on a new Taqman probe to complement previously published outer primers.
- Tested Gull assay so far shows to be highly specific to gulls and pelicans. On-going multi-lab validation testing so far shows this same degree of specificity.
- The Gull assay was shared with NGI collaborators, as well as collaborators in California (SCCWRP), and with the US EPA.
- The Gull qPCR assay was used to quantify the contribution of gull-source *C. marimammalium* in bathing waters during an epidemiological study in Miami, FL.
- A seasonal pattern was observed for the gull-specific *Catellicoccus* qPCR marker that correlated with gull populations. The number of gulls was enumerated by independent automated camera observations taken of the beach to record the populations of people, dogs, and birds during the study. This camera system could specifically discriminate gulls from other types of birds. The

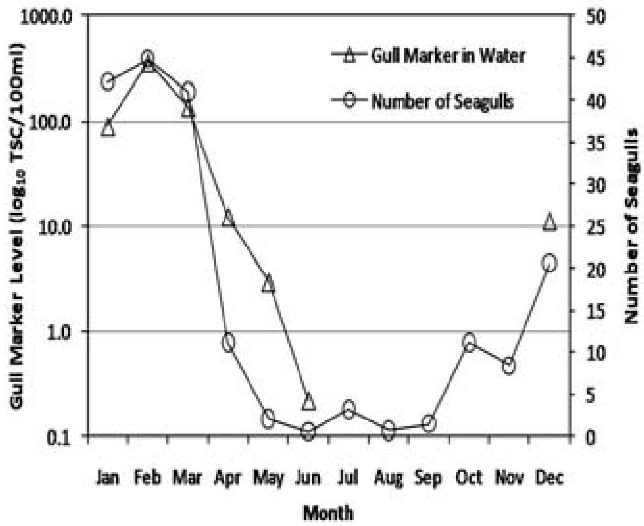


Figure 58. Gull abundance and Gull-2 qPCR signal correlation with season.

pattern of gull abundance enumerated by both camera and by the Gull qPCR assay corresponds to the general annual migration pattern of gulls through southeast Florida (Figure 58).

11. Outreach activities

This work will be used this summer to train a high school and undergraduate student intern. It is also being incorporated into general public outreach information products by the University of Miami Oceans and Human Health Center.

12. Peer Reviewed Articles

C. Sinigalliano et al. 2010. Traditional and molecular analyses for fecal indicator bacteria in non-point source subtropical recreational marine waters. Water Research, 44:3763-3772.

13. Non-refereed articles and reports for this project

None

14. Conference presentations and poster presentations for this project

C. Sinigalliano et al. Protecting Public Health by Quantitative Molecular Detection of Gull and Canine Fecal Contamination in Recreational Waters and Beaches. Oceans and Human Health Gordon Research Conference, June 13-18, 2010, Biddeford, ME.

M. Gidley et al. Microbial contaminant discharge and flux from treated wastewater outfalls and coastal inlets of the southeast Florida region. Oceans and Human Health Gordon Research Conference, June 13-18, 2010, Biddeford, ME.

C. Sinigalliano et al. Microbial water quality of treated wastewater outfalls. 2010 General Meeting of the American Society for Microbiology, May 23-27, 2010, San Diego, CA.

C. Sinigalliano et al. Source Tracking for Public Health Protection: Quantitative Molecular Detection of Gull and Canine Fecal Contamination in Recreational Waters and Beaches. Northern Gulf Institute 2010 Annual Meeting, May 18-20, 2010, Mobile, AL.

C. Sinigalliano et al. Protecting Public Health by Quantitative Molecular Detection of Gull and Canine Fecal Contamination in Recreational Waters and Beaches. Oceans and Human Health Symposium and Workshop, April 12-13, 2010, Washington DC.

M. Gidley et al. Traditional and molecular assessment of fecal indicator bacteria and selected pathogens and their association to health effects at a non-point-source subtropical recreational beach. 2010 National Ocean Sciences Meeting, AGU/ASLO, February 22-26, 2010, Portland, OR.

C. Sinigalliano et al. Development and application of a Taqman qPCR assay for the environmental detection of gull-specific fecal contamination in a non-point-source subtropical recreational beach. 2010 National Ocean Sciences Meeting, AGU/ASLO, February 22-26, 2010, Portland, OR.

15. Personnel from this project hired by NOAA during this reporting period:

Dr. Sinigalliano has been hired by NOAA as of August 17, 2009. His duty station is the NOAA Atlantic Oceanographic and Meteorological Laboratory in Miami, Florida.

16. NOAA Sponsor and NOAA Office the primary technical contact:

Julien Lartigue, NOAA Office of Oceanic and Atmospheric Research

PROJECT 09-NGI-13: MONITORING AND ASSESSMENT OF COASTAL AND MARINE ECOSYSTEMS IN THE NORTHERN GULF

1. Project Leads:

Name	*Title*	*Affiliation*	*Email*
Chet F. Rakocinski	Co-PI	University of Southern Mississippi	chet.rakocinski@usm.edu

2. All Non-Student Personnel funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Kathy VanderKooy	Research Technician	MS	25%	No

3. All Students funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Daneen Menke	BS		50%	No
Claire Matten	BS		25%	No

4. 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.

5. Key Scientific Questions/Technical Issues:

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.

6. Collaborators/Partners:

No collaborators to report

7. Project Duration:

Jul 1, 2009 – Jun 2011

8. Project Baselines:

Contributions to specific NOAA Goals/Objectives:

Part of NOAA's mission is "to improve the capability of coastal zone managers to effectively prevent or reduce the ecological and economic impacts of hypoxia", and to "advance understanding, predicting, and managing the causes and ecological and economic impacts of hypoxia in representative coastal ecosystems". This project will support this effort within the 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".

Contributions to regional problems and priorities: How is the project tied to regional issues and priorities? Identify priority stakeholders, e.g., Gulf of Mexico Alliance, specific user groups.

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. Moreover, population growth and global warming is exacerbating hypoxia worldwide. 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.

How the project has narrowed gaps in regional knowledge, data, model performance, geographic coverage, etc.

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.

9. Objectives/Milestones accomplished in this period

Nineteen 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 7). 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 intense sustained hypoxia in 2008 and further hypoxic stress in 2009.

Table 7. 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. All station events represented by 3 Van Veen gr 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	---
19 Aug 09	---	---	---	Yes	Yes	---
18 Nov 09	---	---	---	Yes	Yes	---
17 May 10	---	---	---	Yes	Yes	---

10. Significant research results, protocols developed, and research transitions

Results – Site 6: May 2008 – June 2009

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. Five benthic sample events taken in 2008 and 2009 represented this site in late spring prior to the onset of hypoxia, in mid-summer during prolonged severe hypoxia, in autumn following a return to normoxia, and in the following spring and early summer of 2009.

Approach: Because macrobenthic process metrics reflect ecosystem function, they should be responsive to effects of eutrophication, including organic enrichment and hypoxia. Basic macrobenthic variables including biomass, abundance, and body size distributions provide information for estimating various process metrics, including production potential, faunal turnover rate (e.g., reciprocal P:B), and normalized biomass size-spectra (NBBS).

Results: Of four process metrics, production potential and total abundance decreased most dramatically after May at site 6 (Figure 59). Mean production potential was still only about half of the May 2008 level one year later in May 2009 (105 vs. 201 mg m^2 d^{-1}). Both metrics were extremely low in July 2008, after which they increased gradually to about half their pre-impact levels in June 2009. Mean individual wet mass of macrobenthic organisms deceased after May 2008, afterwhich mean wet mass remained reduced until June 2009. Accordingly, inferred community turnover rates were highest in May 2008, and remained noticeably lower thereafter.

Normalized biomass-size spectra (NBSS) provide aggregate reflections of trophic organization and ecosystem function. Furthermore, NBSS convey more detailed information about the size structure of the macrobenthic community than mean wet mass. NBSS varied markedly among months at site 6 in connection with hypoxic disturbance (Figure 60).

In May 2008, the NBSS contained high amounts biomass distributed across a very broad range of size classes, whereas in July 2008, biomasses within all size classes were dramatically reduced or absent as an apparent consequence of severe hypoxia. However, considerable recovery of NBSS was evident under subsequent normoxic conditions in November 2008 and May 2009; although levels of biomass in both small and large size classes were still much lower or lacking one year after hypoxic disturbance in May 2009.

The Benthic Index (BI) for the Gulf of Mexico developed by the USEPA did not fare well for conveying macrobenthic status. For example, the BI only fell below the threshold value of 4 in November 2008 and in June 2009 during the study period. The lack of utility for the BI at Site 6 is likely due to its location on the 10 m isobath further offshore than sites generally contributing to the formulation of the BI. Nevertheless, taxonomic diversity was consistently lower more than one year after the initial May 2008 sample event.

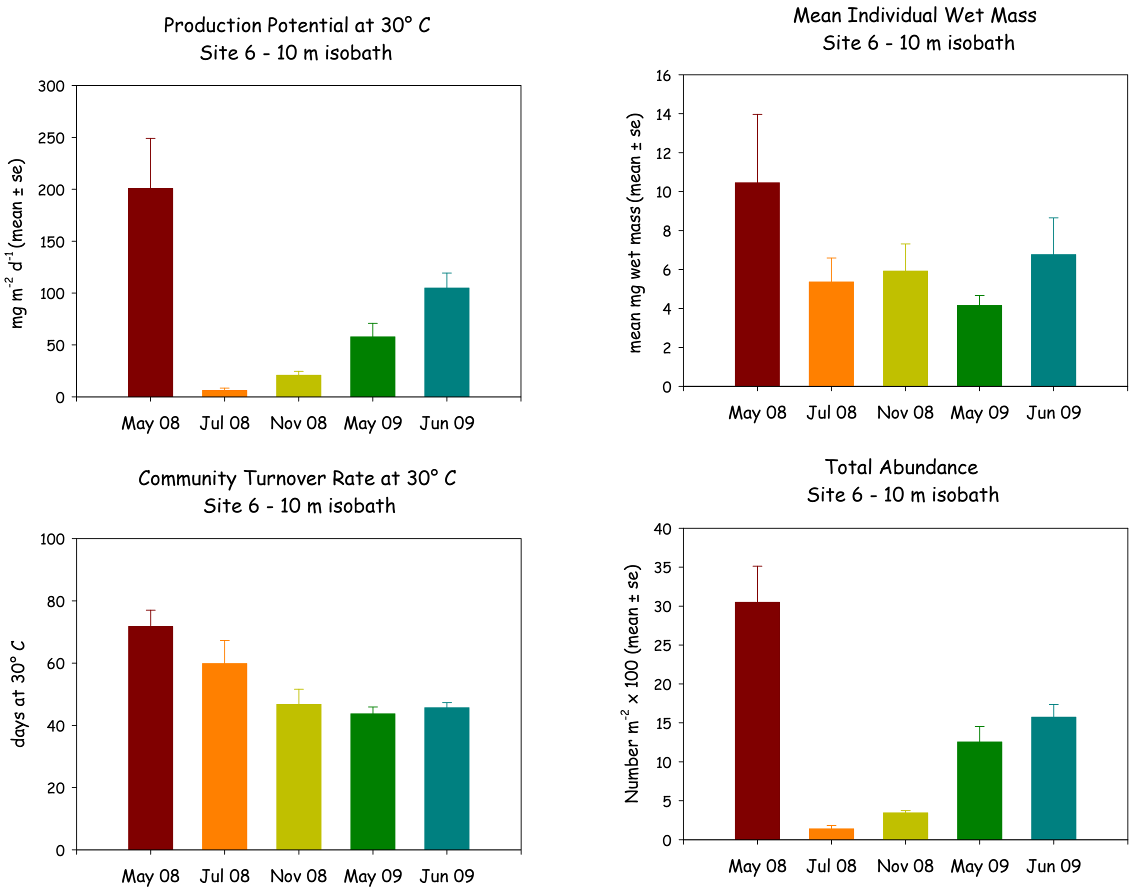


Figure 59. Macrobenthic process metrics from May 2008 through June 2009. After May 2008, severe hypoxic disturbance occurred and continued throughout the summer of 2008.

In May 2008, a taxonomically diverse community was represented by various arthropods, bivalves, cnidarians, and polychaetes, after which tolerant and opportunistic colonists mainly occurred there (Figure 61 and Figure 62). 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. Although the opportunist *Paraprionospio pinnata* and tolerant *Sigambra* spp. were still well represented in May 2009, early stages of the equilibrium acorn worm (*Balanoglossus* sp.) dominated the macrobenthic community both numerically and in terms of biomass at this time. Sensitive amphipods had also reappeared by this time. Compared to May 2008, 43.0 percent of the total abundance (n = 487) and 17.2 percent of the total biomass (15.66 g) was present in May 2009.

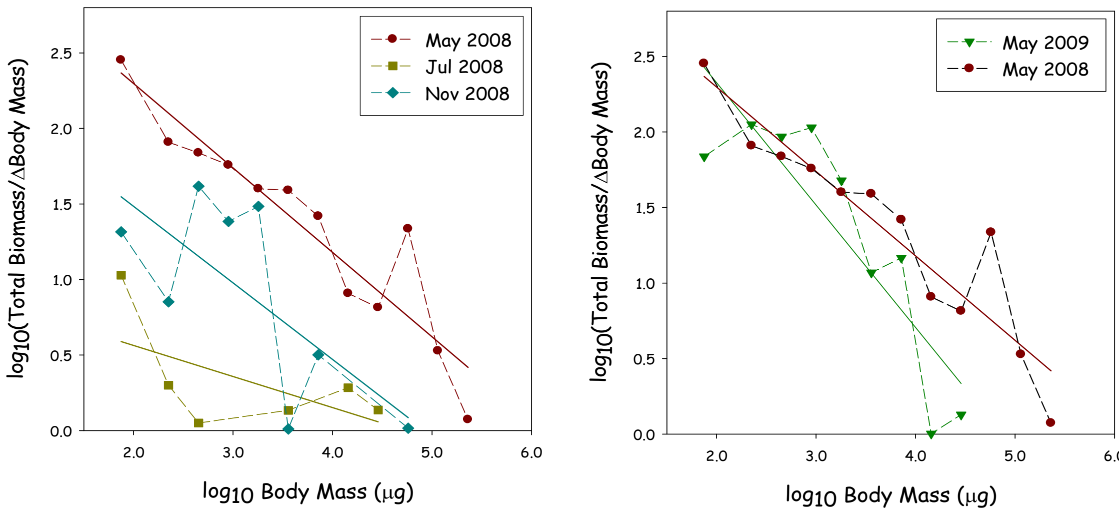


Figure 60. Normalized biomass-size spectra (NBSS) from Spring 2008 to Spring 2009 at site 6.

11. Outreach activities

PIs presented research results at conferences and worked with NGI Outreach program to translate research into outreach materials.

12. Peer Reviewed Articles

Rakocinski, C.F. 2009. Linking allometric macrobenthic processes to hypoxia using the Peters mass balance model. *Journal of Marine Biology and Ecology* – Special Hypoxia Issue 381: S13-S20.

13. Non-refereed articles and reports for this project

None

14. Conference presentations and poster presentations for this project

NOAA - Northern Gulf Institute 2010 Annual Conference. (May 2010), Mobile, AL. Developing macrobenthic indicators of organic enrichment and hypoxia for the coastal Mississippi hypoxic zone.

20th International Coastal and Estuarine Research Federation Conference. (November 2009), Portland, OR. Validating macrobenthic process indicators of organic enrichment and hypoxia. Participant in Organized Oral Session.

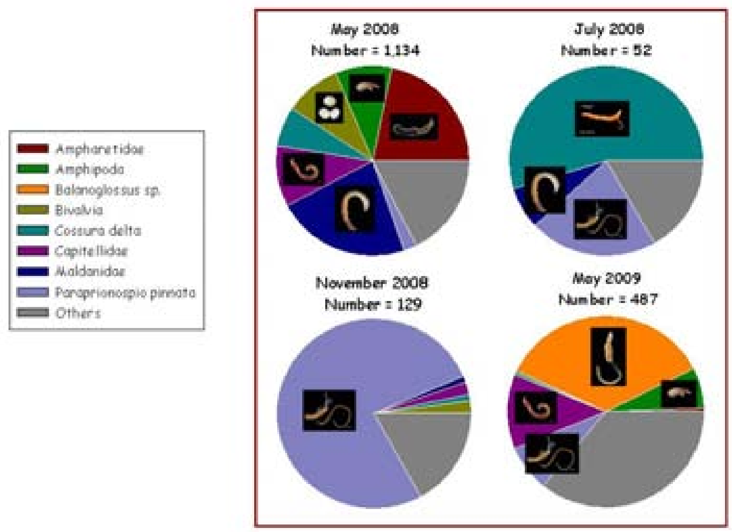


Figure 61. Numerical dominants from Spring 2008 to Spring 2009 at site 6.

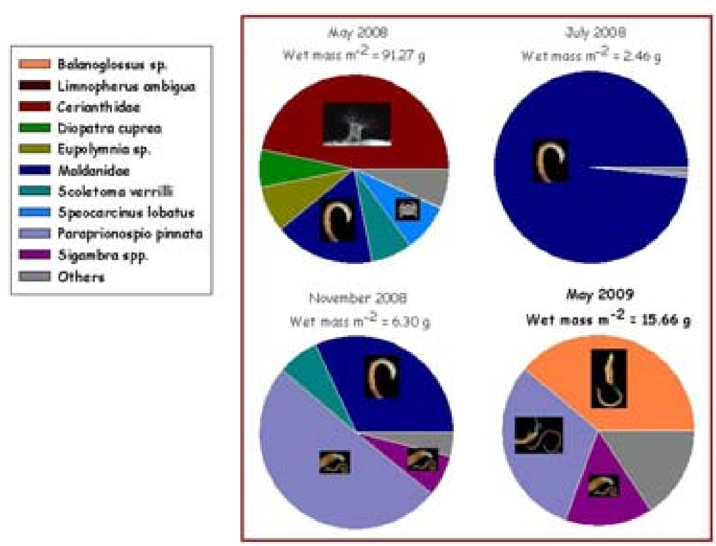


Figure 62. Biomass dominants from Spring 2008 to Spring 2009 at site 6.

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 D. Menke). 20th International Coastal and Estuarine Research Federation Conference. (November 2009), Portland, OR.

15. Personnel from this project hired by NOAA during this reporting period:

None

16. NOAA Sponsor and NOAA Office the primary technical contact:

Julien Lartigue, NOAA Office of Oceanic and Atmospheric Research

PROJECT 09-NGI-14: ASSESSMENT OF ECOSYSTEM SERVICES OF SELECTED COASTAL HABITAT TYPES: TOWARDS A MODEL-BASED TOOLSET FOR MANAGEMENT PLANNING

1. Project Leads:

Name	*Title*	*Affiliation*	*Email*
Richard Fulford	Lead PI	University of Southern Mississippi	Richard.Fulford@usm.edu
Mark Peterson	Co-PI	University of Southern Mississippi	Mark.Peterson@usm.edu
Harriet Perry	Co-PI	University of Southern Mississippi	Harriet.Perry@usm.edu

2. All Non-Student Personnel funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Richard Fulford	Lead PI	PhD	8.3	No
Mark Peterson	PI	PhD	8.3	No
Harriet Perry	PI	MS	8.3	No
Wei Wu	Senior researcher	PhD	8.3	No
Paul Grammer	Research associate	MS	100	No
Cindy Gavins	Research associate	BS	33	No

3. All Students funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Rachel Brewton	BS	MS	100	No

4. Project Abstract:

Identification and valuation of critical habitat is a required component of both Fisheries Management Plans and Fisheries Ecosystem Plans for all federally-managed and most state managed fish species. In order to meet this objective we need better tools for understanding the links between important habitat types and fish and shellfish production. This project is building on two previously developed quantitative models for estimating the ecosystem services of two important coastal habitat types (oyster reef and salt marsh). The first modeling tool is an individual based landscape model that estimates the link between the salt marsh habitat mosaic and production of juvenile fish that use these areas as nursery habitat. The objectives of this project are to take the existing model for the Pascagoula river and apply it to another estuarine system and species to test for mode generality. Through a second collaborative proposal (K. Craig FSU) we are obtaining both spatially explicit habitat data and fish distribution and biomass data from Apalachicola Bay, FL that we can use as input for the IBM. A comparison of model performance and output between these two estuaries will provide for adaptation of the model to allow for a regional scope. In addition we will collaborate with a third NGI project (R. Allee, NOAA) to apply the model to examine the effects of sea level rise on fish production via its effects on the health and distribution of salt marsh. The second modeling tool is a food web model designed to predict the contribution of oyster reef 2^0 production to transient sportfish. This model was developed to describe natural oyster reefs in western Mississippi Sound and it is being applied to a restored oyster reef in St Louis Bay to compare the ecosystem contribution of natural and restored reefs. This project will provide both data and tools for

ecosystem-based management decision making and will directly support the NOAA strategic initiative to advance understanding of ecosystems to improve resource management.

5. Key Scientific Questions/Technical Issues:

The scientific question addressed by this project is how important are two coastal habitat types (coastal salt marsh and oyster reefs) to fishery production. This question is being addressed in stages using mechanistic models combined with empirical data from an index coastal system. The model provides a framework for identification of data gaps and serves as an assessment tool for asking scenario-based questions about habitat loss and alteration. In addition, the model framework represents an important end product of the project as a management tool.

The key ecosystem questions being examined are how much energy is produced per unit time within each habitat type and how much of that energy is exported from the habitat type to the larger coastal ecosystem. Energy export can occur in two ways: it can be transported passively in the form of plankton or detritus, and it can be exported as living biomass. The former is largely a hydrodynamic process, while the latter involves ecological components in the form of food web structure and behavioral variability. Energy transfer efficiency (ETE; proportion of total production recycled or exported) can be estimated with food web models. The amount of ETE that is comprised of export represents a measure of ecological connectivity between a habitat type and the larger ecosystem. This project is intended to measure this component and examine the influence of habitat quality and habitat choice.

In addition we are using the salt marsh habitat model to examine the influence of sea level rise on habitat choice made by juvenile fishes. This question relates climate change to fish production.

6. Collaborators/Partners:

Name of collaborating organization: Dr. Rebecca Allee, NOAA Gulf Coast Services Center

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: 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: Mississippi Department of Marine Resources

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: Data collection support provided for assessment of oyster biomass and water quality data for oyster reef study area in western Mississippi Sound. We are collaborating with MDMR in monitoring and assessment of the restoration natural oyster reef after Hurricane Katrina. Our habitat modeling work will provide valuable baseline data on how the reefs are responding to restoration efforts conducted by MDMR.

Name of collaborating organization: Dr. Kevin Craig, Florida State University Coastal and Marine Laboratory

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: Dr. Craig is collaborating with this project through the FSU component of NGI core funding to collect habitat data in Apalachicola Bay and to help with model development. This addresses the project objective of regionalizing the model

Name of collaborating organization: Dr. Wei Wu

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: Dr. Wu is collaborating on our examination of sea level rise on coastal marsh habitat using a model of sea level rise effects on habitat structure. She is funded by the project for one month of summer salary.

7. Project Duration:

Feb 1, 2010 – Sept 30, 2011

8. Project Baselines:

Contributions to specific NOAA Goals/Objectives:

This research addresses NOAA research priorities as described in the NOAA Strategic Plan to ‘Protect, Restore, and Manage the Use of Coastal and Ocean Resources through an Ecosystem Approach to Management’ through data collection and model development in support of Ecosystem models applicable to management.

Contributions to regional problems and priorities:

The project is also directly relevant to the Gulf of Mexico Alliance theme of Ecosystem-based management. The development of modeling tools intended for management is a key milestone in the development and practical application of EBM concepts. The development of these tools will also benefit our collaborating state agency, MDMR.

How the project has narrowed gaps in regional knowledge, data, model performance, geographic coverage, etc.

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.

9. Objectives/Milestones accomplished in this period

TASK	**Start** Planned/Actual	**Scheduled completion** Planned/Actual
Collect new data on fish distribution, biomass, and energy content in the Pascagoula River (PR) and Apalachicola Bay (AB).	Feb 10/Feb 10	Apr 11/Ongoing
Collect new data on habitat quality in PR and AB.	Feb 10/Feb 10	Apr 11/Ongoing
Use data from (1) and (2) to develop the habitat-production model	Feb 11/Feb11	Jul 11/pending
Use data on loss of salt marsh due to sea level rise from SLAMM modeling to examine impacts of sea level rise on fish production.	Nov 10/Nov 10	Oct 11/pending
Collect species composition and biomass data on restored oyster reef and use model to compare 2^0 production of natural and restored oyster reefs in western Mississippi Sound.	Jun 10/Jun 10	Jan 12/ongoing

10. Significant research results, protocols developed, and research transitions

We have developed two simulation models for assessment of habitat linkages to fisheries production. These two models are being developed as a part of continuing funding into management tools. All data collected as a part of this project were used as input for model development. Details on this will be available in the project final report.

Data collection is ongoing and we will begin model adaptation later this year.

11. Outreach activities

PIs presented research at conference.

12. Peer Reviewed Articles

None

13. Non-refereed articles and reports for this project

None

14. Conference presentations and poster presentations for this project

Assessment of Ecosystem Services of Selected Coastal Habitat Types: Towards a Model-Based Toolset for Management Planning, Paul Grammer, Richard Fulford, Mark Peterson, Wei Wu, Harriet Perry, Rebecca Haehn, USM, 4th Annual Northern Gulf Institute Conference, May 18-20, 2010, Mobile, AL.

15. Personnel from this project hired by NOAA during this reporting period:

None

16. NOAA Sponsor and NOAA Office the primary technical contact:

Julien Lartigue, NOAA Office of Oceanic and Atmospheric Research

PROJECT 09-NGI-15: DATA MANAGEMENT IN SUPPORT OF NOAA'S INTEGRATED ECOSYSTEM ASSESSMENT THROUGH THE NGI ECOSYSTEM DATA ASSEMBLY CENTER

1. Project Leads:

Name	*Title*	*Affiliation*	*Email*
Russ Beard	PI	NOAA	russ.beard@noaa.gov
Dr Rost Parsons	Co-PI	NOAA	rost.parsons@noaa.gov
Dr Ruth Carmichael	Co-PI	DISL	rcarmichael@disl.org
Dr Robert Twilley	Co-PI	LSU	rtwilley@lsu.edu
Eric Roby	Co-PI	NOAA	eric.roby@noaa.gov
Charles Carleton	Co-PI	NOAA	charles.carleton@noaa.gov

2. All Non-Student Personnel funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
VACANT POSITION	Research Associate	MS	75%	No
Charles Carleton	Co-PI	BSEE	100%	No
Dr Ruth C Carmichael	Co-PI	PhD	4%	No
Rachel Nowlin	Co-PI	MS	100%	No

3. All Students funded by this project:

None

4. Project Abstract:

NOAA is developing and expanding the concept and techniques of Regional Ecosystem Data Management (REDM) to support ecosystem observations and ecosystems approaches to management. One of the principal NOAA programmatic efforts supported by REDM is Integrated Ecosystem Assessments (IEA). NOAA is undertaking an IEA for the Gulf of Mexico with pilot efforts beginning in FY09. Under the umbrella of NGI, the EDAC serves as a focal point for data management activities for both NOAA and NGI member institute projects. In the proposed Year 4, the EDAC will expand on current capabilities and move into integration with REDM to support NOAA and NGI Gulf of Mexico IEA efforts and the Gulf of Mexico Alliance (GOMA). Exploration of automatic cataloging of EDAC datasets into the various vocabularies and generation of semantic level metadata supporting IEA's will occur focusing on the DPSIR framework (Driving Forces-Pressures-State-Impacts-Responses). Data discovery, required data transformations and direct integration into IEA models and tools will drive technological development activities and be closely aligned with NOAA Gulf of Mexico efforts and GOMA. Automated end-to-end data management (sensor to archive) techniques will also be investigated. In addition the technical capacity of the EDAC will be enhanced to support broader use with the NGI as a whole. Support to NGI student research efforts (graduate level) is envisioned and would be beneficial to both NOAA IEA and REDM efforts. Additionally historical and near-real time ecosystem data cataloging into the EDAC will be introduced. Work under this element of the project will continue a NOAA affiliation with the Dauphin Island Sea Laboratory (DISL) and expand involvement to Louisiana State University (LSU) on ecosystem data management systems. The goal is develop a NGI member institution internal data management system that links to the existing data management program within the EDAC. Some initial work at LSU and DISL includes novel approaches to encourage and promote faculty participation in the internal data management process. A wealth of ecosystem datasets is held within the various labs

and offices of individual faculty members within an academic marine laboratory or institution. These datasets are invaluable to both assess past and current states of Gulf of Mexico ecosystems. As these datasets are often not contained in a central database, they can be difficult to locate and are not readily accessible or searchable. Many potential end users may even be unaware that these datasets exist. Furthermore, faculty and laboratory personnel are often reticent to dedicate already tight time and financial resources to archiving past or current datasets. In fact, proprietary tendencies concerning publication often discourage data sharing. This problem is compounded when a faculty member moves to another facility. Data are valuable only if data and its metadata are readily available. Hence, making these datasets readily available and accessible and overcoming hurdles to faculty participation will facilitate scientific studies, public education, and outreach. The resulting data management systems will enhance the Regional Ecosystem Data Management effort and expand the capability of EDAC to gather ecosystem data.

5. Key Scientific Questions/Technical Issues:

The continued development and enhancement of the EDAC follows the approach outlined in NOAA's FY-2010-2014 Strategic Investment Question: *Integrated Ecosystem Assessments: A synthesis and quantitative analysis of information on relevant physical, chemical, ecological and human processes in relation to specified ecosystem management objectives.*

"The production of routine integrated ecosystem assessments (IEAs) represents a significant and forward-looking leadership opportunity for NOAA to more effectively address ocean and coastal resource management issues in the United States and internationally. Ocean and coastal marine ecosystems are both complex (multiple simultaneous issues to be resolved) and complicated (relationships between living and non living components of ecosystems behave in non-incremental, abrupt or unanticipated ways). Typically, management benchmarks and forecasting tools are developed assuming relatively simple interactions among ecosystem components, if at all, and they cannot predict how *ecosystems* may respond to new pressures or how pressures affect biological communities as opposed to single species. The need for a new class of *ecosystem-level* assessments and management benchmarks is clearly articulated in recommendations by the U.S. Ocean Commission, the NOAA Science Advisory Board, and the Ocean Research Priorities Plan. "

The EDAC will assist in the evaluation of the ability of NOAA and partners to:

1. Identify major human and natural factors affecting ecosystems and the scale at which ecosystems or their parts will be assessed
2. Organize the relevant existing ecosystem data (from various sources) and develop appropriate environmental indicators of ecosystem status
3. Prioritize assessments development and link ecosystem status indicators to human and natural pressures on the ecosystem that drive change
4. Evaluate ecological and economic impacts of management options, consistent with NOAA and other statutory responsibilities, and
5. Use IEAs as the science tool supporting an adaptive approach to management to achieve target levels for appropriate ecosystem goals while avoiding thresholds for undesirable ecosystem conditions. (FY-2010-2014 Strategic Investment Question)

Continued EDAC funding will support several GOMA II Action Items as drafted by the Priority Issue Teams (PITs) including (Nutrients) NIR-4 *Increase Regional Coordination to reduce Hypoxia in Gulf of Mexico Coastal Waters and Estuaries*; (Ecosystem Integration and Assessment) EIA-1 *Develop a Gulf of Mexico Ocean and Coastal Mapping Plan*; EIA-2 *Enhance and broaden the Priority Habitat Information System to provide public access and delivery of current and historic local, state, and federal Gulf of*

Mexico environmental data; EIA-4 *Determine the value of Ecological and Socioeconomic Services within the Gulf of Mexico.*

6. Collaborators/Partners:

Name of collaborating organization: Naval Research Lab Stennis, MS, Naval Oceanographic Office, Stennis, MS, National Data Buoy Center, Stennis, Ms, and National Estuarine Research Reserves, US

Date collaborating established: 2006

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: Data products and access for assembly within EDAC including ocean model output, satellite imagery and airborne imagery.

7. Project Duration:

Oct 1, 2009-Sept 30, 2011

8. Project Baselines:

Contributions to specific NOAA Goals/Objectives:

Goals 1 and 5. This project has helped build the Ecosystem Data Assembly Center which supports ecosystem based management efforts. It also supports the NOAA critical mission activities with data integration and student involvement.

Contributions to regional problems and priorities:

This project helps the Gulf of Mexico Alliance accomplish its integrated ecosystem management goals and environmental education priorities.

How the project has narrowed gaps in regional knowledge, data, model performance, geographic coverage, etc.

By incorporating data and metadata into EDAC it is more useable and accessible to resources managers and researchers in the northern Gulf region.

9. Objectives/Milestones accomplished in this period

NCDDC (1): Quarterly updated Inventory of data compiled within EDAC -- Current

NCDDC (2): Collection Service and Collection Service Portal – Complete (see EcoWatch Data Search)

NCDDC (3): OceanNOMADS enhancements – Complete (see THREDDS aggregation and NCOM America Seas)

NCDDC (4): Data Meta-Mapping Service – Complete range of metadata transform services developed and have been shared nationally (NOAA Metadata Transform Working Group).

NCDDC (5): EDAC Annual Report – to be prepared

NCDDC (6): Evaluation and recommendations on LSU and DISL data management systems

DISL (1): Incorporation of data and metadata from NGI and NCDDC sponsored projects (initially Heck, Habitat Restoration Research at DISL; Carmichael, West Indian Manatee habitat data) into EDAC – data and metadata submitted (in progress)

LSU (1): Incorporate data and metadata from NGI sponsored projects into the EDAC (Dr Sara Green departed LSU (original Co-PI)) . Funding received Jan 2010. New LSU Associate being assigned. In progress.

Work done with DISL this year:

MERMAid Support/Metadata Publishing - Worked with DISL Data Specialist to publish FGDC metadata for harvest into the GOS (Geodata.gov) clearinghouse. DISL has a total of 22 publicly available metadata records.

DISL Data Archive - Received 9 individual datasets for archive from DISL. PI's agreed to have the data archived, but only 1 PI has agreed to have the data made publicly available. This dataset (#5, #6, and #7 below combined) was accessioned and archived at NODC as NODC Accession 0054500. The other datasets were sent to NCDDC.

Metadata Record Titles for Individual Datasets Received:

1. How do piscivorous fish assemblage, species richness, and density impact indirectly invertebrate prey consumption by invertivores in coral reef environment?
2. Dauphin Island Sea Lab (DISL) Shark Longline Project: Coastal Gulf of Mexico
3. Trophic Dynamics of Created Salt Marshes in Coastal Alabama
4. Temporal variability in summertime bottom hypoxia in shallow areas of Mobile Bay, Alabama
5. Compilation of Net Primary Productivity and Producer Nutritional Quality Data Sets from 1962 - 2000 for Ecosystem Carbon Flow Study
6. Compilation of data of primary production, herbivory, decomposition, export and burial data sets from 1965 to 1997 for different types of marine communities.
7. Data set for Cebrian, J. 2004: Grazing on benthic primary producers. In: S.L. Nielsen, G.T. Banta & M.F. Pedersen (eds.): Estuarine nutrient cycling: the influence of primary producers.
8. The effects of invasive Eurasian milfoil, *Myriophyllum spicatum*, on community structure and trophic interactions of estuarine fishes.
9. Alabama Oyster Reef Restoration: Larval Recruitment in Mobile Bay

10. Significant research results, protocols developed, and research transitions

Gulf of Mexico Alliance (GOMA) Water Quality Monitoring Metadata Database

The updated GOMA water quality metadata search project was successfully demonstrated using the EDAC system. This project combined the previously developed metadata database with a new web-based search interface. The new interface is capable of doing searches by both geographic and metadata criteria. For example, you can draw a polygon around an area and get the locations of all water quality measurements for that area, or restrict it to only getting locations where chlorophyll is measured.

The phase of the project where a new, more detailed, database was to be created was cancelled due to funding constraints.

The EcoWatch Data Search

The EcoWatch collection and syndication services allow constant access to NDBC, NWS, and NERRS in-situ measurements. The EcoWatch Data Search was developed to allow a geographic search for these data sources. The user can draw a polygon on a map and get a list of all stations within that polygon. The user may also specify whether the stations should be from NWS, NERRS, NDBC, or all sources. Data from the search results may be viewed as tables, and graphed vs. time. The user may also specify a set of search results to get as RSS, KML, or JSON from the EcoWatch Syndicator.

The EcoWatch Data Search may also be configured to search for ERDDAP data sets from an administrator-specified set of ERDDAP servers. Search results contain links to the ERDDAP data/graphing page for the found data set.

THREDDS Aggregations of EDAC data

Various data sets at EDAC including NCOM and IAS have been configured as aggregations in THREDDS. An aggregation lets a series of files be treated as a single continuous data set. This makes long-term analysis easier and allows clients to connect to a set of data through a consistent URL rather than having to look for individual files named by timestamp. THREDDS catalog configuration tools have been used to make these aggregations better conform to standards for variable naming and metadata. Most of these aggregations are accessible via ERDDAP and therefore can be searched via the EcoWatch Data Search.

Navy Coastal Ocean Model (NCOM) American Seas

This new variant of NCOM, provided by the Naval Oceanographic Office, has higher resolution than the NCOM global Region 1 data, and has more data fields. It is now being published on EDAC servers.

11. Outreach activities

NGI Conference: NOAA/NGI Diversity Intern Training Session was provided on Thursday, May 20th. Kathy Martinolich provided the training. A follow-up webinar session was provided as well on May 26th for more hands-on MERMAid training.

12. Peer Reviewed Articles

None

13. Non-refereed articles and reports for this project

None

14. Conference presentations and poster presentations for this project

None

15. Personnel from this project hired by NOAA during this reporting period:

None

16. NOAA Sponsor and NOAA Office the primary technical contact:

Julien Lartigue, NOAA Office of Oceanic and Atmospheric Research

PROJECT 09-NGI-16: CONTRASTING HIGH AND LOW RELIEF FISHERY HABITATS OF THE NORTHEASTERN GULF: HABITAT DELINEATION, FOOD WEB COMPONENTS AND SPATIAL DEMOGRAPHICS

1. Project Leads:

Name	*Title*	*Affiliation*	*Email*
Doug DeVries	Project Lead	NOAA Fisheries Service	doug.devries@noaa.gov
Chris Gardner	Co-PI	NOAA Fisheries Service	chris.gardner@noaa.gov
Robert Allman	Co-PI	NOAA Fisheries Service	robert.allman@noaa.gov
Gary Fitzhugh	Co-PI	NOAA Fisheries Service	gary.fitzhugh@noaa.gov

2. All Non-Student Personnel funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Chris Gardner	Co-PI	BS	100	Yes, NMFS Panama City Lab

3. All Students funded by this project:

None

4. Project Abstract:

This project will bridge gaps in knowledge between inshore and offshore fisheries, explicitly habitat and biological interactions. Our initial study focused on the fishery habitat distributed across a shelf depth gradient in order to identify the relevant spatial scales for community and population demographic structure. As this project continues, understanding the gradient of productivity from low to high relief habitats becomes increasingly important in gauging population and community responses. Objectives include: 1) examining temporal and spatial patterns in fish community structure, abundance and demographics in an area of high relief hard bottom habitat known as the Three-by-fives (up to 10 m relief); continuing to do the same on the first NGI study's low relief sites; and making inter-habitat comparisons of these parameters, 2) delineating and quantifying hard bottom habitats in the Three-by-fives area and in cross-shelf transects (10-30 m depths) in the Big Bend region (Apalachee Bay) using side scan sonar, 3) collecting geo-referenced habitat video and still images for ground-truthing side scan data, 4) characterizing diets, predator-prey interactions, resource overlap and habitat-associated differences in diet of the reef fish communities in the Three-by-fives area within and across depths and habitats; and comparing those findings with those from the current NGI study's low relief sites, and 5) comparing growth and condition of fishes between high- and low-relief habitat types, and examining the effect of the scale of a species' movements (or site fidelity) on these parameters.

5. Key Scientific Questions/Technical Issues:

Overriding questions of this project are: 1) what are the relationships of inner and mid-continental shelf hard bottom habitats to fisheries production in the northeastern Gulf of Mexico (Gulf) and how are these habitats connected to those on the outer shelf, and 2) what is the distribution and extent of these habitats. More specifically for the Three-by-fives area compared to low relief sites: 1) what are the hard bottom fish communities, and how do they vary spatially and temporally, 2) what is the size and age structure of the dominant, primarily exploited fish species 3) what are the food habits, trophic levels, and trophic pathways of these species, and 4) do growth and condition of red snapper, vermilion snapper, red porgy, and gray triggerfish vary between high and low relief habitats, and if so, is there a relationship between observed differences and stage-specific site fidelity?

6. Collaborators/Partners:

Name of collaborating organization: Jeff Chanton, James Nelson, Chris Koenig, and Felicia Coleman, Florida State University

Date collaborating established: Jul 2006

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: FSU conducts the food-web analysis; particularly related to stable isotope methodology NOAA Fisheries' primary role has been to conduct the field work, sampling, and community study integral to FSU's trophic pathways project.

7. Project Duration:

Jul 2009- Sept 2011

8. Project Baselines:

Contributions to specific NOAA Goals/Objectives:

Our work primarily addresses the ecosystem mission goal of the NOAA 5-year plan; specifically, to advance understanding of ecosystems, to improve resource management, and to forecast ecosystem events. Our integrated mapping and habitat classification also meets the "Explore Oceans" objective. Specific milestones in NOAA's 5-year research plan addressed by this study include 1) map habitat types and identify key habitat functions 2) create models coupling physical variability and biological effects on productivity, fish recruitment and distribution and 3) develop the next generation of multi-species fisheries and food-web production models. This project also contributes to at least two of the general goals of NOAA's strategic plan, including 1) increase the number of fish stocks managed at sustainable levels and 2) increase the number of regional and coastal ecosystems delineated with indicators of ecological health and socioeconomic indicators that are monitored and understood.

Contributions to regional problems and priorities:

One of the five priority issues of regional significance identified in the Governors' Action Plan for Healthy and Resilient Coasts, drafted by the Gulf of Mexico (GOM) Alliance, is identification and characterization of Gulf habitats to inform management decisions. The GOM Alliance noted that habitat maps are 1) essential for other priorities such as establishing and maintaining long-term monitoring programs to determine the status and trends of marine habitats, 2) are necessary if states hope to improve ecosystem-based management, and 3) would considerably enhance efforts to designate essential fish habitat. The two cross-shelf transects we mapped off NW Florida (and the third we plan to map in Oct 2010) with high resolution multibeam sonar as part of our first NGI project, as well as the Three-by-fives and 10 cross-shelf transects in the Big Bend mapped with side scan sonar in March and April 2010 as part of the current 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.

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. 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 as red tides, hurricanes, oil spills, oil drilling, and burying of pipelines, and separate them from those of fishing.

A recent critical development, the Deepwater Horizon MC 225 oil spill, is highlighting how important this type of spatially explicit information is in assessing injury and establishing restoration. The metadata from this project has been listed as a baseline source for the National Resource Damage Assessment (NRDA) (NOAA Office of Restoration and Response).

How the project has narrowed gaps in regional knowledge, data, model performance, geographic coverage, etc.

The side scan mapping already accomplished has provided very detailed, high resolution geo-referenced data on the extent, form, and distribution of high relief hard bottom habitat in a large area south of Panama City and ESE of Cape San Blas. This area (Three-by-fives) has significant populations of a large number of reef fish species, many of which are heavily exploited. The multiple cross-shelf transects surveyed with side scan in the Big Bend area have already provided a tremendous amount of information on the distribution and variability in hard bottom habitat in that area, probably increasing by 3-4 fold the amount of inner shelf mapped there. That information has already been incorporated into the sample site universe of the NMFS Panama City fishery independent reef fish survey and enabled the switch from a systematic to a stratified random sampling design, which in turn will lead to increasing precision, more statistical power, and increased cost-effectiveness. The ground truth video data collected at the Three-by-fives and in the Big Bend has already proven to be extremely useful for interpreting the side scan data and developing a habitat classification system.

9. Objectives/Milestones accomplished in this period

Biological and environmental data were collected in October 2009 as part of the annual monitoring on the long term monitoring sites. Video analysis on these sites is currently being preformed. Additional specimens have been collected for stable isotope analysis and are being sent to FSU as part of the NGI collaboration. These samples expand the trophic analysis by both depth and geographic area.

An essential part of this project involved side scan sonar mapping of hard bottom features. A Marine Sonic 600/1200 kHz digital sonar system was ordered in September, but the fully functional system was not received until December. Training was preformed and several test runs were made over known sites to gain proficiency with the sonar. Sonar maps were generated on two cruises for a total of seven days (working 24 hrs per day) to assist with development of strata and the sample site universe. The mapping was divided into two areas; the Three-by-fives and the Big Bend. The Three-by-fives was mapped (approximately 15 km^2) to reveal the majority of the known ridgeline, which parallels the isobaths in the area, running NW to SE for approx. 22 km. Vertical relief is up to 10 m in some areas. Over 200 hard bottom reefs were identified. On subsequent trips, 20 of those sites were ground-truthed using a geo-referenced drop camera and ROV to characterize habitat types and to examine potential survey sites. Side scan mapping trips were also preformed on the inner- and mid-shelf areas of Florida’s big bend around FSU’s marine lab. A total of 10 cross-shelf transects were mapped (600km total length x ~150m width). These revealed approximately 1200 hard bottom reef sites. Preliminary habitat classification information has been collected and shared with FSU collaborators for reef fish surveys. An FSU intern is currently working on measuring the total area of each hard bottom habitat in three of the cross shelf transects.

10. Significant research results, protocols developed, and research transitions

Side scan sonar mapping has revealed large numbers of hard bottom reefs in the NE Gulf of Mexico (Figure 63). Habitat classification has been standardized and shared with FSU and Florida Fish and Wildlife Research Institute. Habitat types of high relief ledges, continuous rock, scattered hard bottom, and sponge/algal reef are displayed with side scan backscatter and geo-referenced images in the appendix (Figure 64 and Figure 65). With high-resolution habitat maps, sites are now being selected for ROV visual surveying and sample collection within low and high relief strata in the Three-by-fives. Sampling will begin in the fall and will continue twice a year (warm and cold seasons) for two years.

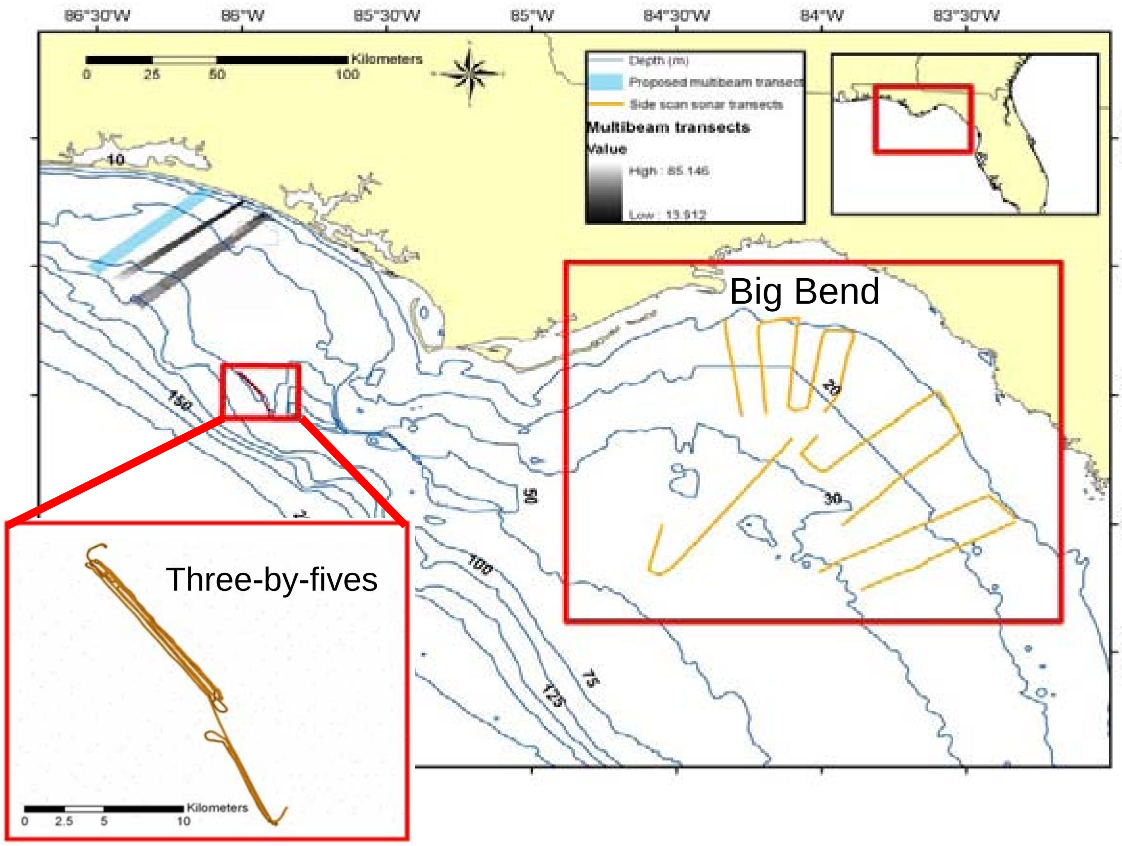


Figure 63. NGI study areas. To the west, are the long term sampling transects which are sampled every fall. The area of detail shows side scan sonar mapping transects from the Three-by-fives area. Furthest east, lies the cross-shelf side scan sonar transects in the big bend. These are prospecting lines for hard bottom habitat in the FSU marine lab's study area.

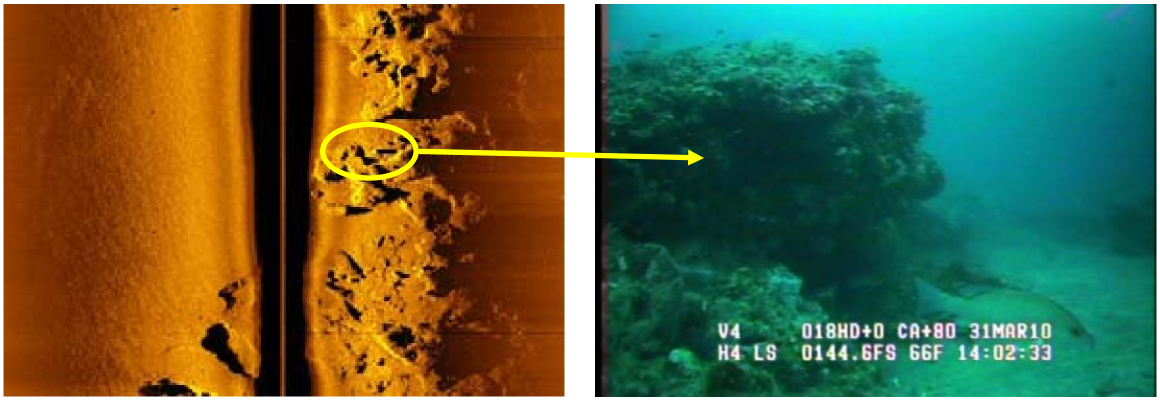


Figure 64. Side scan sonar image and corresponding image from an ROV of high relief rocky habitat in the Three-by-fives.

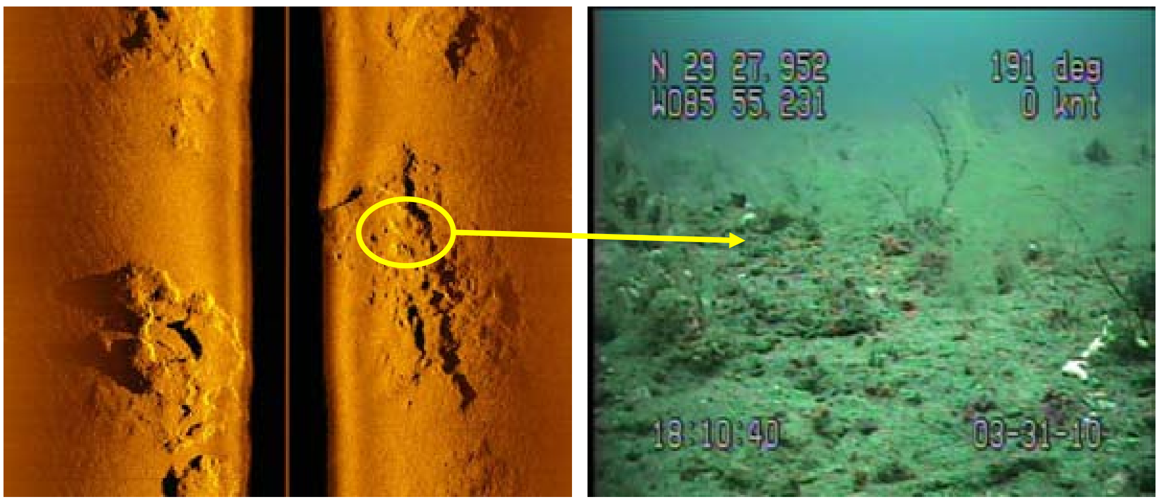


Figure 65. Side scan image and geo-referenced drop camera image of low relief rocky habitat in the Three-by-fives.

11. Outreach activities

Date: 11/19/09

Location: Gulf Coast Community College

Description: C. Gardner spoke to two classes on practical uses of math. Topics included using ROV's with scaling lasers, using trigonometry for video coverage estimates, and sonar theory.

Approximate Number of Participants: 50

Date: 3/27/10

Location: NMFS Panama City Lab

Description: C. Gardner spoke to boy scouts who were attempting to earn an oceanography merit badge. Topics included remote sensing techniques, the scientific method, and general oceanography.

Approximate Number of Participants: 20

Date: 4/28/10

Location: NMFS Panama City Lab

Description: D. DeVries and C. Gardner spoke with middle school honors students about reef fish sampling and underwater videography.

Approximate Number of Participants: 20

12. Peer Reviewed Articles

None

13. Non-refereed articles and reports for this project

None

14. Conference presentations and poster presentations for this project

C. Gardner, D. DeVries, G. Fitzhugh, R. Allman, and James Nelson. Cross-shelf reef fish community structure and demographics on natural reefs off northwest Florida. 2010. Oral presentation. 2010 Annual Northern Gulf Institute Conference, Mobile, AL.

C. Gardner, D. DeVries, P. Raley, R. Allman, and G. Fitzhugh. Contrasting high and low relief fishery habitats of the Northeastern Gulf: Habitat Delineation, Food Web Components, and Spatial Demographics. 2010. Poster. 2010 Annual Northern Gulf Institute Conference, Mobile, AL.

J. Nelson, J. Chanton, C. Koenig, F. Coleman, D. DeVries, and C. Gardner. Flux by Fin: Using stable isotopes to trace fish mediated carbon and nutrient flux in the northeast Gulf of Mexico. 2010. Oral presentation. 2010 Annual Northern Gulf Institute Conference, Mobile, AL.

C. Gardner, D. DeVries, D. Naar, and B. Donahue. Mapping hard bottom reef fisheries habitat off northwest Florida- needs, methods, and status. 2010 Poster. National Habitat Assessment Workshop, St. Petersburg, FL. May 2010.

D. DeVries, C. Gardner, J. Brusher, and G. Fitzhugh. Under what circumstances, if any, do we need to post-stratify species/habitat data? 2010 Poster. National Habitat Assessment Workshop, St. Petersburg, FL. May 2010.

Gardner, C. and D. DeVries. Cross-shelf patterns in fish community structure and demographics on hard bottom habitat off northwest Florida. 2010. Poster, 2010. Florida Chapter American Fisheries Society. February 2010.

Nelson, J. D. DeVries, C. Gardner, and R.M. Wilson. Near-shore reefs are important transition habitats in the N.E. Gulf of Mexico. Oral presentation, 2010. Florida Chapter American Fisheries Society. February 2010.

Gardner, C. and D. DeVries. Cross-shelf patterns in fish community structure and demographics on hard bottom habitat off northwest Florida. 2009. Poster, 2009 American Fisheries Society Conference, Nashville, TN.

15. Personnel from this project hired by NOAA during this reporting period:

None

16. NOAA Sponsor and NOAA Office the primary technical contact:

Julien Lartigue, NOAA Office of Oceanic and Atmospheric Research

PROJECT 09-NGI-17: NORTHERN GULF INSTITUTE INTEGRATED EDUCATION AND OUTREACH PROGRAM

1. Project Leads:

Name	*Title*	*Affiliation*	*Email*
Jarryl Ritchie	CO-PI	NGI Program Office	jritchie@ngi.msstate.edu
Tina Miller-Way	CO-PI	Dauphin Island Sea Lab	tmiller-way@disl.org

2. All Non-Student Personnel funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Jarryl Ritchie	CO-PI	MA	50%	No
Maggie Dannreuther	Research Associate	MBA	100%	No
Suzanne Shean	Research Associate	MS	35%	No
Gabriel Brackman	Research Associate	BS	20%	No
Tina Miller-Way	CO-PI	PhD	100%	No
Mendel Graeber	Educator	BA	50%	No
Jenny Cook	Educator	MS	50%	No

3. All Students funded by this project:

None

4. Project Abstract:

The objectives for the education component of this program include: (1) translate and deliver NGI research results aligned to state and federal science standards to K-12 students in the Northern Gulf region; (2) develop and implement curricular materials based on NGI research results for formal and informal educators along the coast and up the watershed aiming to address the issues throughout the ecosystem; and (3) increase awareness and understanding of the importance of the Northern Gulf region by the public via the Estuarium (the public aquarium located on the campus of Dauphin Island Sea Lab) and other similar institutions.

The outreach objectives are to: (1) translate and disseminate NGI research results to NOAA Gulf of Mexico Regional Collaboration Team, Gulf of Mexico Alliance, among the NGI research community and to the public; (2) participate in outreach activities in the region to build NGI brand and recognition; (3) increase stewardship of the Northern Gulf ecosystem with outreach programs and topical workshops presented by NOAA Coastal Services Center; and (4) provide internship management and workforce development opportunities and connections for NOAA employees and NGI affiliate students.

5. Key Scientific Questions/Technical Issues:

Not applicable for this project.

6. Collaborators/Partners:

This project has complete collaboration of the 5 NGI university partners and NOAA.

7. Project Duration:

Oct 1, 2009 – Sep 30, 2011

8. Project Baselines:

Contributions to specific NOAA Goals/Objectives:

NOAA Goal 5 – mission support in translating NGI research efforts for the scientific and general communities to use.

Contributions to regional problems and priorities:

NGI Education and Outreach project participants are active in GOMA and other regional teams.

How the project has narrowed gaps in regional knowledge, data, model performance, geographic coverage, etc.

This program attempts to share knowledge across the entire northern Gulf region in a consistent way that helps with the NGI branding and public's understanding of NGI as a reliable source of information.

9. Objectives/Milestones accomplished in this period

- Continued incorporation of NGI research results into K-12 coastal science curricula at DISL (existing and new modules)
- Offering watershed curricula through DISL's traveling marine science classroom, the BayMobile
- Participation in several regional outreach events including My Two Boots (Pascagoula, MS), Open House at the Roy Hyatt Environmental Center in Pensacola, FL, Ocean Commotion at Louisiana State University, ShrimpFest in Gulf Shores, AL, Open House at the Environmental Studies Center, Mobile, AL.
- Continuation of weekly Boardwalk Talk series (informal conversations with the public about variety of topics relevant to coastal science) in DISL's *Estuarium*
- *Implemented 'The NGI Activity Cart' for informal interactions with Estuarium visitors; cart includes materials and directions for short interactive lessons about NGI topics*
- Incorporation of NGI research projects and results into content for interactive kiosks in *Estuarium* offering additional field, boardwalk, and interactive experiences for *Estuarium* visitors
- Developing a new watershed physical display in the *Estuarium*
- Production of final script for 'Nutrients in the Watershed' video aimed at middle school students, now in post-production (adding animation) stage
- Developed teacher workshop, *Regional Issues in the Gulf of Mexico* for formal and informal educators, have advertised and filled first session, will be held July 6-9, 2010
- Developed service project for K-12 students visiting DISL based on a DISL NGI research project
- Translate research activities and results and develop materials to educate and focus attention on the unique contributions NGI researchers contribute to understanding the Gulf of Mexico and enhancing conservation. Products include "Research Spotlights", "The Portal" newsletter, and NGI web presence, and NGI List serve
- Host, organize and participate in professional symposia, conferences, teacher workshops and stakeholder meetings to feature NGI research activities (e.g., NGI Annual Conference and NGI Speaker Series)
- Continue administrative support of internship activities to enhance NOAA workforce development

10. Significant research results, protocols developed, and research transitions

Not applicable for this education and outreach project.

11. Outreach activities

General Description: NGI Annual Conference

Date: May 18-20, 2010

Location: Mobile, AL

Description: Annual science meeting for NGI with paper and poster presentations, keynote speakers, and networking

Approximate Number of Participants: 170

12. Peer Reviewed Articles

None

13. Non-refereed articles and reports for this project

Northern Gulf Institute September 2009. ***Northern Gulf Institute Science, Education, and Research Management Plan,*** Northern Gulf Institute, Mississippi State University, Mississippi State, MS.

Northern Gulf Institute July 2009. ***Northern Gulf Institute Cooperative Institute Progress Report: Reporting Period July 1, 2008 – June 30, 2009,*** Northern Gulf Institute, Mississippi State University, Mississippi State, MS.

14. Conference presentations and poster presentations for this project

Presented Paper ***NGI Education and Outreach Overview*** by T. Miller-Way, M. Dannreuther, Jarryl B. Ritchie, Suzanne Shean at NGI 2010 Annual Conference – Mobile, AL, May 18, 2010

Presented Paper ***NGI Education and Outreach: Enhance NGI's Impact through Communication, Education, and Collaboration*** by Jarryl B. Ritchie, T. Miller-Way, M. Dannreuther, M. Carron, J. Harding, J. Lartigue at AGU Ocean Sciences Meeting 2010 – Portland, OR, February 23, 2010

Presented Paper ***The Resilience Social Climate Survey (CoastalIQ) - Measuring Coastal Knowledge and Attitudes Toward Coastal Hazards, Storm Preparation, Evacuation Decisions, Resilience and Community*** at the 10th Annual Coastal Development Strategies Conference in Biloxi, MS, May 2009.

15. Personnel from this project hired by NOAA during this reporting period:

None

16. NOAA Sponsor and NOAA Office the primary technical contact:

Julien Lartigue, NOAA Office of Oceanic and Atmospheric Research

PROJECT 09-NGI-18: FORECASTING EPISODIC CHANGES IN HURRICANE INTENSITY AND STRUCTURE OVER THE GULF OF MEXICO

1. Project Leads:

Name	*Title*	*Affiliation*	*Email*
Christopher M. Hill	Project Lead	MS State Univ. / GRI	hillcm@gri.msstate.edu
Michael Koziara	Co-PI	NOAA/NWS	mike.koziara@noaa.gov
Felix Navejar	Co-PI	NOAA/NWS	felix.navejar@noaa.gov

2. All Non-Student Personnel funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Christopher M. Hill	PI	M.S.	50%	No
Yee Lau	Research Associate	M.S.	25%	No

3. All Students funded by this project:

None

4. Project Abstract:

The primary goal of this project is to provide greater insight into forecasting time-sensitive trends of rapid formation, changing intensity, and changing wind field area (or size) of hurricanes over the Gulf Mexico in the interest of reducing the uncertainty in the risk posed to Gulf Coast residents and infrastructure. The focus is to identify key features or processes present in the ambient atmosphere and in the Gulf of Mexico that led to critical episodic changes in the intensity and structure of Gulf hurricanes, particularly with three recent hurricanes: Humberto, Gustav, and Ike. The project employs both an analytical and numerical modeling approach to study the processes of hurricane formation, intensification, and expansion. New observational analyses may uncover atmospheric features or processes not previously considered in the case of each hurricane. A new recognition technique of cloud and precipitation patterns from satellite and radar data is proposed to assist in the identification of forming or intensifying hurricanes. Finely-detailed numerical weather simulations may help to validate findings of the constructed analyses and present other, currently unobservable details of the hurricanes. The assimilation of data used in the constructed analyses may contribute to the improvement of the hurricane simulations. The modeling study will also include observing system simulation experiments to test the potential efficacy of assimilating data from UAS and WISDOM platforms. The findings of analytical and numerical modeling approaches may yield insight into causes of the episodic changes experienced with hurricanes, and therefore provide improved guidance for forecasting similar, future events.

5. Key Scientific Questions/Technical Issues:

- What are the key processes and features of the atmosphere leading to the episodic changes of intensity and size in each hurricane?

- What are the respective contributions of the Gulf of Mexico waters and the adjacent land masses to the atmospheric processes and features leading to episodic changes in hurricane intensity and size?

- Which observing platforms best depict, as well as best contribute to preparing the simulation of, the conditions leading to episodic changes in hurricane intensity and size?

- Can the threat of rapid hurricane formation to citizens and infrastructure be best emphasized through the pre-emptive issuance of a watch, warning, or other public advisory (i.e. “warn on forecast” as opposed to “warn on detection”)?

6. Collaborators/Partners:

Name of collaborating organization: National Weather Service

Date collaborating established: Oct, 1, 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: Mr. Koziara and Mr. Navejar agreed to collaborate within the context of this project. Each will have provided oversight of the project work, and each will have contributed to the work as it relates to their operational experience with the subject matter.

7. Project Duration:

Jan 1, 2010 – Oct 30, 2010 (no-cost extension pending)

8. Project Baselines:

Contributions to specific NOAA Goals/Objectives:

NOAA Goal 3. This project directly contributes to the NOAA Strategic Goal of information on Weather and Water.

Specifically, the project most closely follows these 3-5 Year Milestones outlined in the NOAA 5-year Research Plan for 2008-2012:

- Provide decision-support services based upon probabilistic model guidance for coastal emergency management officials for storm surge and related hazards during land-falling tropical storms and hurricanes.
- Improve accuracy in intensity forecasts for tropical storms and hurricanes through accelerated tropical cyclone modeling improvements.
- Evaluate the utility of probabilistic forecasts for hazardous weather and explore “warn-on-forecast” concepts.

Contributions to regional problems and priorities:

This project attempts to address the need of government entities to mitigate and respond to the effects of wind and storm surge from tropical cyclones of widely varying size and intensity.

How the project has narrowed gaps in regional knowledge, data, model performance, geographic coverage, etc.

Readily available data are used to search for key processes and features, as well as trends, not previously noted in the operational forecast setting. The new Hurricane Weather Forecasting & Research (HWRF) model is being tested to simulate specific case events. The project is specific to the study of hurricanes over the Gulf of Mexico.

9. Objectives/Milestones accomplished in this period

A statistical survey of the intensity and size of Gulf tropical cyclones, observed during 1988-2008, has been performed.

Findings from this study have been presented at three conferences.

10. Significant research results, protocols developed, and research transitions

A statistical survey of the intensity and size of Gulf tropical cyclones (tropical storms and hurricanes), observed during the period of 1988 to 2008, was performed. The purpose of the survey was to identify cyclones of contrasting size and intensity, as well as to identify trends in location and date of cyclones categorized by size and intensity.

A total of 74 tropical cyclones were found to have affected the Gulf during 1988 to 2008, consisting of 41 tropical storms (55%), 19 hurricanes (26%), and 14 major hurricanes (19%). Of the 74 cyclones, 46 (62%) formed over the Gulf of Mexico and 28 (38%) cyclones originated elsewhere. And of the 74 cyclones, 29 (or 39%) had a wind speed >34 knots contained within a field area of at least 155,500 km^2, which represents one-quarter of the maximum possible circular area over the Gulf of Mexico.

Ultimately, these results will contribute to the understanding of how cyclone size and intensity vary with individual cyclones, as well as how cyclone size and intensity interrelate. The three hurricanes of specific study, Humberto, Gustav, and Ike, represent one case of a small, rapidly forming hurricane, and two cases of a large, intense hurricane, respectively.

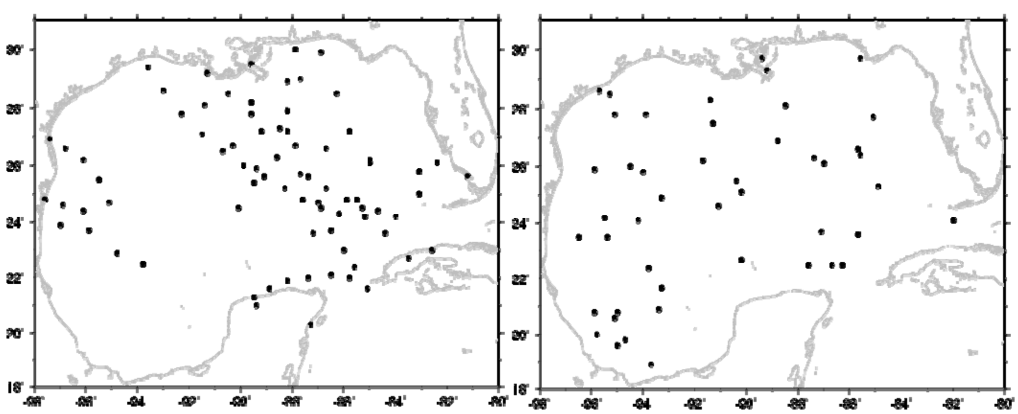


Figure 66. LEFT: Tracks of 14 major hurricanes affecting the Gulf of Mexico during 1988-2008. RIGHT: Origin points of 46 tropical cyclones over the Gulf of Mexico during 1988-2008

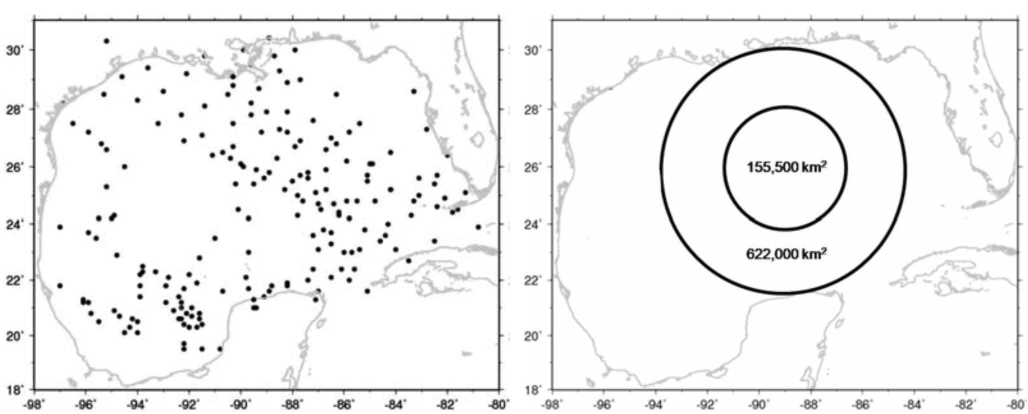


Figure 67. LEFT: Tracks of tropical cyclones with >34-kt-wind area of 155,500 km2 or greater over the Gulf of Mexico during 1988-2008. RIGHT: Circular areas of 155,500 km2 and 622,000 km2 compared with the area of the Gulf of Mexico.

11. Outreach activities

General Description: Informal Tutorial Workshop

Date: May 4, 2010

Location: Stennis Space Center, MS

Description: This tutorial provided participants with the details of key software components to a new numerical weather prediction system called the Hurricane Weather Research & Forecasting Model (or HWRF), used to model atmospheric and oceanic physics for the purpose of accurately simulating a tropical cyclone.

Approximate Number of Participants: 6

12. Peer Reviewed Articles

None

13. Non-refereed articles and reports for this project

None

14. Conference presentations and poster presentations for this project

Hill, C.M., M. Koziara, F. Navejar, P. J. Fitzpatrick, and Y. Lau, 2010: Collaborative study of episodic changes to intensity and structure of Gulf hurricanes. 64th Interdepartmental Hurricane Conference, March 1-4, Savannah, GA. Office of the Federal Coordinator for Meteorology. (poster)

Hill, C. M., P. J. Fitzpatrick, and Y. Lau, 2010: Analysis of wind field variations of major hurricanes in the Gulf of Mexico. 29th Conference on Hurricanes and Tropical Meteorology, May 10-15, Tucson, AZ. American Meteorological Society. (poster)

Hill, C.M., M. Koziara, F. Navejar, P. J. Fitzpatrick, and Y. Lau, 2010: Collaborative study of episodic changes to intensity and structure of Gulf hurricanes. Northern Gulf Institute 2010 Annual Conference, May 18-20, Mobile, AL.

15. Personnel from this project hired by NOAA during this reporting period:

None

16. NOAA Sponsor and NOAA Office the primary technical contact:

Julien Lartigue, NOAA Office of Oceanic and Atmospheric Research

PROJECT 09-NGI-19: INTEGRATED RESEARCH FOR THE NORTHEAST GULF OF MEXICO BIG BEND REGION

1. Project Leads:

Name	*Title*	*Affiliation*	*Email*
Eric P. Chassignet	PI	Florida State University	echassignet@coaps.fsu.edu
William K. Dewar	Co-PI	Florida State University	dewar@ocean.fsu.edu

2. All Non-Student Personnel funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Dmitry Dukhovskoy	Research Faculty	PhD	50%	No
Steven Morey	Research Faculty	PhD	33%	No
Christopher Stallings	Postdoctoral Associate	PhD	8%	No
Stephanie White	Research Scientist	MS	92%	No

3. All Students funded by this project:

Name	*Category*	*Degree*	*% Salary funded from this project*	*Is individual located at a NOAA Lab?*
Stefan Bourgoin	BS	PhD	100%	No
Chin Ying Chien	BS	MS	8%	No
Precious Lewis	BS	MS	25%	No
Geoffrey Montee	BS	MS	50%	No
James Nelson	MS	PhD	100%	No
Aaron Paget	MS	PhD	25%	No
Jacob Rettig	BS	MS	50%	No
Michael Santema	MS	PhD	8%	No
Mollie Taylor	BS	MS	17%	No
James Waller	MS	PhD	8%	No
Jesse Fields		BS	17%	No
Alejandra Mickle		BS	33%	No

4. Project Abstract:

The project is an integrated study of the marine ecosystem of the northern West Florida Shelf (WFS) (including the Big Bend Region (BBR) using an interdisciplinary observational, experimental, 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:

1. 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;
2. 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.
3. 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.

5. Key Scientific Questions/Technical Issues:

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 characterizing habitat and predator-prey interactions of key species, 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.

6. Collaborators/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, as well as with colleagues not directly involved in the NGI, including Dr. Sunhui Sim (FSU Geography Department).

7. Project Duration:

Jan 2007 – Sept 2011

8. Project Baselines:

Contributions to specific NOAA Goals/Objectives:

NOAA Goal 1. Our project contributes directly to the NOAA goals/objectives on Ecosystem Based Management, Climate Variability and Coastal Hazards. With regards to Ecosystem Based Management, our efforts to clarify the on-shore/off-shore transport mechanisms of gag will be of central importance to sustaining this and similar types of fisheries. We acknowledge that a fundamental role is played by seagrass beds and shallow water reefs, thus stressing the need to understand their community structure and function and provide management measures that protect these habitats. In addition, our attempts to quantify benthic primary productivity in the BBR are important to management decisions affecting regional water clarity and secondary productivity. Riverine input to the chemical and biological structure of the

BBR is essential to river management decisions and potentially to fisheries productivity. Knowledge of on and off-shore transport mechanisms will affect coastal hazards and management decisions at multiple scales. 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 event, by causing long-term modifications to riverine inflow, and by altering the suite of species and their trophic interactions within the ecosystem. Generic regional warming can be expected to impact the community function and structure of the regional seagrass beds and shallow water reefs.

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 (Apalachicola Estuarine Reserve, Florida Fish and Wildlife, Florida Dept of Agriculture) involved in monitoring the coastal bays and oceans in our area.

Contributions to regional problems and priorities:

Two important regional problems are (1) sustaining commercial and recreational fisheries, including those for gag and oysters, both of which have tremendous economic value; and (2) water quality and quantity within the region. These two issues are inextricably linked, and have gained significance because of the long-term drought in the southeastern United States and the water wars associated with the Apalachicola-Flint-Chattahoochee watershed. The impact on several marine industries, including tourism and fisheries, is potentially significant and people involved in these industries are clearly the primary stakeholders.

How the project has narrowed gaps in regional knowledge, data, model performance, geographic coverage, etc.

Our research along a transect in the Northeastern Gulf of Mexico (NECGOM) investigating benthic primary production is designed to quantify the contribution of microalgal communities inhabiting the sandy sediment to total ocean productivity in this region. The productivity data relates 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. 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.

The fish ecology section of this project will define for the first time the horizontal linkages between onshore seagrass bed communities and offshore spawning sites associated with reef fish productivity. We will also define the physical characteristics responsible for transporting grouper larvae from offshore spawning sites to the inshore seagrass beds, the use of these habitats and shallow-water reefs as primary and secondary nursery habitats, respectively, and the possible role that climatological fluctuations in these beds will play in the growth trajectories of individual year classes.

9. Objectives/Milestones accomplished in this period

Data Center Milestones

● Completed fully automated quality control and data distribution via the FSU/COAPS/NGI web pages for all routine meteorological data from N7. This includes rapid update (every 10 minutes) and ability to download daily, quality controlled files in netCDF format.

● Completed rapid dissemination of ocean temperature and salinity data from T/S sensors mounted on N7 via the web page. Data are provided via cabling from sensors to the tower logger and then via line of sight telemetry (established by transport and meteorology groups).

● Jacob Rettig successfully defended his M.S. project in computer science. Jacob developed and implemented the automated data management system for the N7 meteorological data.

Ecology Milestones

●*Weather effects on growth rates.--*Completed the field work and laboratory processing of samples (Thistle)

*Trophic Transfer--*Food webs on shallow reef systems as far as 25 km from these seagrass beds utilize a significant portion of seagrass derived material and that a major fisheries species', gag, muscle tissue is composed of an average of 15 % seagrass derived. This mechanism may also be an important conduit by which organic contaminants such as methylmercury are transferred from coastal habitats into pelagic food webs.

Characterization of faunal communities—(1) We completed data entry of habitat characterization of 92 sites throughout the Big Bend and have started spatial analyses and linking the data into a GIS framework. (2) We completed examinations of 717 individual gag collected from eight areas across the west coast of Florida for stomach content analyses and isotopic analyses. (3) We demonstrated that juvenile gag shift energy allocation from fast somatic growth to storage just prior to moving from seagrass beds to shallow water reefs; and (4) we have completed our initial surveys of shallow water soft coral-sponge reefs used as secondary nursery habitat for gag; (5) We provided research opportunities and training for six undergraduate students and one high school student. In addition to the three themes and projects described below, our work has also contributed to additional research opportunities for five graduate students.

Characterization of Nutrient Inputs to Coastal Ecosystems of the Gulf of Mexico—(1) We held an initial project meeting at FSUCML in December 2009 involving researchers from both institutions to discuss sampling strategies and gear standardization between the two effort; (2) We initiated biweekly trawl and hydrographic sampling in East Bay in April 2009. We collaborated with Mike Wetz and Natalie Byars to use their continuously monitoring water quality equipment to obtain high spatial resolution information on surface temperature, salinity, dissolved oxygen, fluorescence, and turbidity in East Bay; (3) We continued monthly sampling for juvenile spot throughout Apalachicola Bay in collaboration with ANERR; and (4) We recruited one undergraduate student (N. Kortessis) and one graduate student (M. Taylor) to participate in the project. Each prepared a poster presentation for the 2010 Northern Gulf Institute annual meeting.

Transport Milestones

● (1) Telemetry of T and S data at K-tower completed, T, S online; (2) Transmission electronics built and tested for telemetry of environmental data collected at K-tower bottom mound; (3) Underwater cable prepared for installation at K-Tower, installation procedure initiated; (4) Time series data quality controlled and compiled; (5) Current meter data of bottom ADCPs analyzed and compiled; (6) Production rate measurements completed and analyzed; (7) Temperature gradient sensors installed, first data analyzed; (8) Station B bottom mound re-installed, first data collected

Milestones for Meteorological Monitoring

● (1) We currently provide real-time meteorological and oceanographic data (T and salinity) at depth from tower N7. Anticipate real-time data reporting from multiple levels at tower N7 (GTKF1) to begin in July 2010; (2) Towers in AF network have been assigned permanent IDs from NOAA NDBC; (3) Re-designed the lower boom to reduce threat of water damage and will be implemented in summer of 2010; (4) Set- up calibration system at Love Building for all radiation instruments and performed internal calibrations against factory standards. (5) Installed initial instrumentation for complete surface radiation budget at tower, consisting of net radiation, surface emissivity, surface temperature, upwelling and downwelling shortwave and longwave radiation budgets.

10. Significant research results, protocols developed, and research transitions

Ecology Component

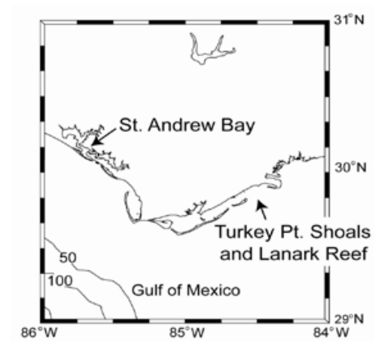


Figure 68. Sampling sites for gag growth rates in the NEGOM.

The FSU ecology team is investigating the importance of climate variability, trophic transfer, and nursery habitat on the ecology of one of the more economically important fishes in the region, gag (*Mycteroperca microlepis*). 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, characterizes 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). By integrating habitat-specific information on juvenile fish production and egress within an ecosystem-level nitrogen (N) mass balance model, we can estimate the relative contributions of N inputs to the Big Bend Region (BBR) of the WFS derive from (1) the Apalachicola River, (2) atmospheric N, and (3) the seasonal migration offshore of inshore-associated forage species.

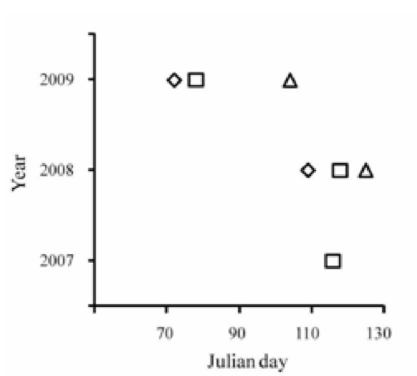


Figure 69. Average date of settlement at our sites during our study showing the among-site-within-year and within-site-among-year differences. Note that only Turkey Point Shoal was sampled in 2007. Diamond, Lanark Reef; Square, Turkey Point Shoals; Triangle,St. Andrew Bay

__The Influence of Weather on Growth Rates in Juvenile Gag.__

Understanding the causes of variability in the growth rates during ontogeny is critical from a management perspective. In this portion of the study, the influence of weather (based on temperature, salinity, and light) and dissolved oxygen concentration (following Perez-Dominguez et al. 2006) on growth rate and in diet of early juvenile gag in the NEGOM is examined at three sites, on Turkey Point Shoals, Lanark Reef, and St. Andrew Bay (the latter in cooperation with NOAA NMFS Panama City Laboratory) (Figure 68). All sites were sampled for three years from mid April to mid

July, thereby covering the period when early juveniles arrive at the seagrass beds and establish a benthic existence.

Under investigation are how the following parameters vary among sites and years: date of fertilization, date of settlement, growth rate in terms of length and weight, abundance, size and age at capture. While analyses are incomplete, apparent already are differences in the average date of settlement. In particular, we found that the average date of settlement varied significantly among sites and years 4 (**Error! Reference source not found.**). These differences suggest that the component of population models for this stage will have to be determined on regional or finer scales, and raise the question of whether date of settlement could be predicted from more fundamental physical quantities, such as flow patterns and temperature. Completed to date are determinations of the lengths, weights, growth rates, and ages of all specimens (including age at settlement).

To assess diet, the amount of each prey type in stomach contents was quantified. In year 4, we finished processing fish guts, and analyzed data. The remainder of the funding period (ending October 1, 2010) will be devoted to further analysis, completion of Burgoin's thesis, and development of manuscripts for publication.

Trophic Transfer

Each fall, millions of pounds of juvenile fish (including gag) and forage fish (including pinfish) migrate from the seagrass beds of the NEGOM to overwinter on offshore reefs. They are often met by a "wall of mouths", that is, piscivorous species that feed heavily to build up fat reserves in anticipation of late winter spawning. Understanding the role this fish-mediated nutrient flux plays in sustaining fisheries production is vital to management of these valuable fishery resources. The results obtained last year indicated that dietary shifts were tractable and that adult gag tissue turnover was driven primarily by metabolic turnover and not growth.

The next steps addressed these objectives:

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 NEGOM. 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 an ecosystem level nitrogen mass-balance model of the NEGOM fisheries.

Dr. Chanton and Nelson (Ph. D. student) have analyzed hundreds of tissue samples of both offshore top-level predatory fish and forage species (using samples supplied by Dr. DeVries, NOAA-NMFS Panama City Lab as part of his NGI project, and by Nelson) and estuarine specimens of gag and pinfish (supplied by Nelson's studies) for ^{13}C and ^{15}N to link transfer of plant productivity inshore to offshore production. This collaboration will continue in year 5.

Table 8. Mean δ 15N, δ 13C, and δ 34S values for all of the species collected from the seagrass, shallow reef, and deep reef habitats. The (±) is the standard deviation of the mean of 5 individual's stable isotope values.

Depth	**Common Name**	**Species Name**	**Mean δ ^{15}N**	**Mean δ ^{13}C**	**Mean δ ^{34}S**
Seagrass					
	croaker	*Micropogonias undulatus*	12.3 ± 1.2	-17.3 ± 1.3	10.1 ± 2.6
	gulf flounder	*Paralichthys albigutta*	10.0 ± 1.1	-16.1 ± 1.5	8.4 ± 2.6
	mojarra	*Eucinostomus argenteus*	10.1 ± 0.5	-16.9 ± 0.5	7.2 ± 1.2
	pigfish	*Orthopristis chrysoptera*	11.1 ± 0.8	-16.9 ± 0.8	6.8 ± 2.7
	pinfish	*Lagodon rhomboides*	10.3 ± 1.4	-17.0 ± 1.4	8.1 ± 2.8
	seatrout	*Cynoscion nebulosus*	10.7 ± 0.7	-16.6 ± 0.7	7.5 ± 2.0
	shrimp	*Penaeidae*	8.1 ± 0.8	-16.8 ± 0.8	3.7 ± 2.4
	silver perch	*Bairdiella chrysoura*	11.5 ± 1.3	-17.5 ± 1.3	11.6 ± 2.2
	spot	*Leiostomus xanthurus*	11.5 ± 0.9	-15.9 ± 0.9	12.0 ± 0.8
	Mean		**10.5 ± 1.2**	**-16.9 ± 0.6**	**8.6 ± 2.5**
<30m	bank sea bass	*Centropristis ocyurus*	11.9 ± 0.8	-17.4 ± 0.3	17.3 ± 0.5
	blue angelfish	*Holacanthus bermudensis*	13.1 ± 0.3	-19.7 ± 0.4	18.2 ± 0.8
	gray snapper	*Lutjanus griseus*	14.4 ± 1.1	-16.6 ± 1.0	15.0 ± 2.7
	inshore lizard fish	*Synodus foetens*	12.9 ± 0.6	-17.6 ± 0.3	17.2 ± 1.2
	red grouper	*Epinephelus morio*	14.3 ± 0.3	-17.3 ± 0.2	18.0 ± 0.6
	red snapper	*Lutjanus campechanus*	14.5 ± 0.6	-17.6 ± 0.5	18.3 ± 1.0
	sand perch	*Diplectrum formosum*	12.7 ± 0.6	-17.0 ± 0.2	16.6 ± 0.7
	scamp	*Mycteroperca phenax*	14.3 ± 0.3	-17.5 ± 0.1	17.0 ± 0.7
	tomtate	*Haemulon aurolineatum*	12.7 ± 0.4	-17.8 ± 0.3	17.5 ± 0.7
	Mean		**13.3 ± 0.9**	**-17.4 ± 1.0**	**17.2 ± 1.0**
>30m	bank sea bass	*Centropristis ocyurus*	12.6 ± 0.4	-17.8 ± 0.3	17.1 ± 0.7
	gray snapper	*Lutjanus griseus*	14.3 ± 0.4	-17.5 ± 0.3	18.5 ± 0.6
	inshore lizard fish	*Synodus foetens*	12.2 ± 0.7	-17.6 ± 0.6	18.5 ± 0.8
	red grouper	*Epinephelus morio*	14.4 ± 0.5	-17.3 ± 0.4	17.7 ± 0.8
	red porgy	*pagrus pagrus*	12.9 ± 0.3	-19.2 ± 0.8	17.1 ± 0.4
	red snapper	*Lutjanus campechanus*	14.2 ± 0.4	-17.7 ± 0.4	18.5 ± 0.6
	sand perch	*Diplectrum formosum*	12.2 ± 0.5	-18.4 ± 0.2	18.5 ± 0.4
	scamp	*Mycteroperca phenax*	14.8 ± 0.3	-17.7 ± 0.5	19.0 ± 0.5
	tomtate	*Haemulon aurolineatum*	12.5 ± 0.3	-18.2 ± 0.2	18.4 ± 0.4
	vermillion snapper	*Rhomboplites aurorubens*	12.2 ± 0.4	-18.3 ± 0.6	18.3 ± 0.7
	Mean		**13.2 ± 1.0**	**-18.1 ± 0.6**	**18.1 ± 0.6**

Results-- In general, the isotope values observed for species sampled from seagrass beds were enriched in ^{13}C, depleted in ^{15}N, and depleted in ^{34}S relative to offshore species (Table 8). The centroid location of the seagrass $\delta^{13}C$ and $\delta^{34}S$ values differed significantly from all other groups. The nearest group was gag muscle tissue (distance = 7.89, p=0.0001). Values for reefs < 30 m were most similar to those of the offshore-reefs but are significantly enriched in ^{13}C and depleted in ^{34}S relative to species that occurred on offshore reefs. The shallow water reefs differed significantly in centroid location to all groups except gag muscle tissue (distance= 0.59, p=0.26). The next nearest group was deep water reefs (distance= 1.41, p= 0.002). The offshore species had smallest ranges for each of the isotopes sampled which is an indication that there is less variability in inputs of primary production in deep water. The deep water reef species differed significantly in centroid location to all groups. The nearest group was shallow water reef species (distance = 1.41, p= 0.002).

We found that adult female gag muscle tissue was significantly depleted in ^{34}S during spawning season relative to gag gonad $\delta^{34}S$ values outside of spawning season (F= 7.993 p= 0.006, Figure 70). Gag muscle tissue differed significantly in centroid location to all groups except gag muscle tissue (distance= 0.59, p=0.26). The next nearest group was deep water reefs (distance= 1.41, p= 0.002).

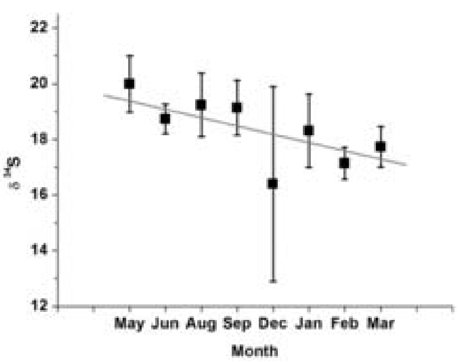


Figure 70. Monthly variation in sulfur isotope value of gag gonad tissue. February and March are peak spawning months for gag. The error bars indicate the standard deviation of the mean of the individual samples. The gray line represents the best fit linear regression line.

Seagrass Production in Offshore Food webs **--** Our results here suggested that seagrass-derived production entered offshore food webs via the annual migrations of small seagrass dwelling fishes. The $\delta^{34}S$ values for gag provide the clearest indication of the incursion into the gag food web on reefs < 30m deep. We base this on several lines of evidence. (1) we eliminated the possibility of an alternate source of light sulfur existing in shallow reef food webs because of the range of values associated with marine planktonic production and marine particulate organic matter (17-21 ‰) (Chanton and Lewis 2002, Chasar et al. 2005).

In marine environments, the only significant source of depleted sulfur is either from the runoff of terrestrial organic matter or from sulfate reduction in anoxic sediments (Chanton and Lewis 2002). The typical range of values approaches those observed for the seagrass end member (-10 - +10 ‰ (Chanton and Lewis 2002, Chasar et al. 2005). If either in-situ sulfate reduction or terrestrial runoff was a significant source of light sulfur in offshore food webs, we would anticipate depleted $\delta^{34}S$ across all species on shallow sites relative to species in deep water.

What we find, however, is that piscivorous fish such as lizardfish, sandperch, and scamp (Bowman et al. 2000) have significantly depleted $\delta^{34}S$ values at shallow sites compared to the same species in deeper water, suggesting a dietary shift, whereas species that feed primarily on crustaceans or other invertebrates such as blue angelfish, red grouper, and red snapper (Moe 1969, Wells et al. 2008) show no change in $\delta^{34}S$ between shallow and deeper water sites. We conclude that piscivorous fish inhabiting shallow water reefs 15-25km offshore seagrass beds consume significant numbers of the forage species that egress from the seagrass beds in the late fall.

The $\delta^{34}S$ and $\delta^{13}C$ values of the gag muscle suggest a significant influence of seagrass-derived production in the diet. If we assume the mean values for seagrass and deep water reefs to be end members, we can construct a simple 2-source mixing model and estimate the contribution of seagrass derived material to gag biomass, based on the equation**:**

a) $A(x) + B(y) = C$ b) $x + y = 1$

where, A is the mean $\delta^{34}S$ value of the deep reef species (18.1 ‰), B is the mean $\delta^{34}S$ value of seagrass species (8.6 ‰), C is the mean $\delta^{34}S$ value gag muscle tissue (16.7 ‰), x is the percent contribution of the deep reef species to gag muscle tissue, and y is the percent contribution seagrass species to gag muscle tissue. Because, the values of x and y must equal 1, we can rearrange equation 1a and solve for x and y. Based on this model, the average gag muscle tissue contains ~15% seagrass-derived production.

This result is somewhat surprising because all fish in this case were captured at depths > 30m, yet only gag contained a strong seagrass signal. This suggests that our original hypothesis-- that gag consume the seagrass-dwelling species when those forage species migrate to deep water offshore-- is incorrect. If it were true, then we would expect the seagrass signal to show up in other offshore piscivores. A more parsimonious explanation is that gag obtain the signal during the pre-spawning period when they characteristically aggregate in relatively shallow water in the winter to feed prior to spawning (Coleman et al 1996), and deposit large amounts of adipose tissue (Jorgensen et al. 1997, Marshall et al. 1999). This conclusion is supported by the shift from more enriched offshore $\delta^{34}S$ values of the gonad tissue prior to spawning season to lighter $\delta^{34}S$ values during spawning season (Figure 71). Because gag gonad tissue turnover rates are rapid, particularly during spawning season, we conclude that energy stored during the migration into shallow water is utilized for egg production (Nelson et al. 2010).

Characterization of faunal communities in seagrass meadows and shallow water reefs

We have made significant progress on the three overarching themes of our NGI-funded research. (Theme 1) *Spatial patterns of abundance, distribution, and composition of faunal communities that may serve as prey for juvenile gag in seagrass beds of the BBR.* Using a generalized random-tessellation stratified (GRTS) design -- a spatially-balanced approach (Stevens and Olson 2004) -- we sampled 92 sites with beam trawls across the entire BBR seagrass beds (Figure 72). All captured prey (fishes and invertebrates) were identified to the lowest possible taxonomic level, measured, and counted. Data entry is complete and both spatial analyses and linking the data into a GIS framework have begun. We are targeting 100 sampling sites in the BBR for summer 2010. Given the oil spill from the Deep Horizon Oil Well, our efforts may serve as the most comprehensive baseline dataset of the Big Bend seagrass beds.   NGI funds also contributed to an annual census conducted in seagrass beds across the west Florida coast to measure recruitment of gag. The census, implemented in 1999, has been ongoing annually since 2003. Data from the census were used in the recent gag stock assessment update (NMFS 2009). (Theme 2) *Diets of juvenile gag in seagrass beds.* Here, we seek to understand how diets vary ontogenetically (individuals ranging from 10-25 cm) and spatially (across the west Florida coast, WFC). To address these issues, we

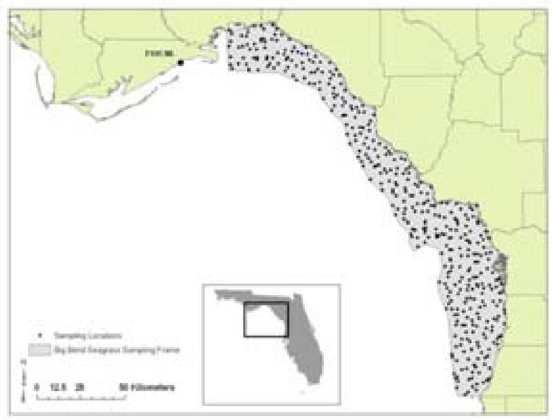


Figure 71. Sampling locations (n = 100) chosen using GRTS across the BBR seagrass bed.

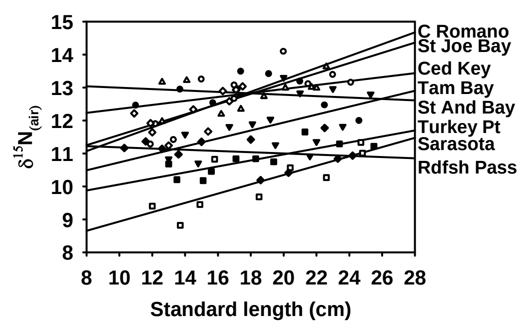


Figure 72. Nitrogen (N) isotopic signature for gag collected from eight sites along the Florida coast in the northeastern Gulf of Mexico.

combine two methods, each having a unique strength in enhancing our understanding of diets: stomach content and stable isotope analyses. Stomach content studies provide a direct method of assessing diet. We have examined 717 gag collected from eight areas across the WCF (Figure 73). Prey were identified to lowest possible taxonomic level, measured for size (length when appropriate, mass, & volume) and counted. Stable isotope analyses provide an indirect method for assessing the sources ($\delta^{13}C$) of an organism's diet as well as the trophic level at which it feeds ($\delta^{15}N$). We have completed isotope analyses for 96 gag for C and N (Figure 73), and plan to run these same samples for Sulfur (S) (combing C and S provides a conservative estimate of sources). In addition, we have experimentally demonstrated juvenile gag do not exhibit preference between two prey commonly found in their stomachs, regardless of initial prey density (Stallings 2010; study funded in part from NGI).

(Theme 3) *Population dynamics of juvenile gag on nearshore reefs*. Gag move from seagrass beds (where they first settle) to nearshore reefs, where they remain for the following 3-5 years. We find that juvenile gag shift energy allocation from fast somatic growth to storage just prior to moving onto the reefs (Stallings et al. In Press; study funded by NGI and NOAA). Our ongoing work seeks to understand how the abundance and size distribution of juvenile gag varies through time on these reefs. We have completed site selection and have chosen four reefs located at depths from 10-18m and distances offshore from 13-20km. This study design will allow us to assess whether juvenile gag are moving offshore in a "stepping stone" pattern. We have begun conducting surveys on each reef, completing the surveys for spring and summer/fall 2009 and spring 2010. Preliminary data suggest deeper reefs located further offshore may support older size and age classes than shallow depths closer to shore (Figure 74). We will continue to survey the four reefs on at least a quarterly frequency. **See Milestones.**

Characterization of Nutrient Inputs to Coastal Ecosystems of the Gulf of Mexico.--This work is a collaborative effort between FSU, GCRL, the Apalachicola National Estuarine Research Reserve (ANERR), and NOAA partners to extend prior NGI-funded work at both institutions to address regional issues faced by coastal and fishery managers. Our proposal builds on an empirically-based fish

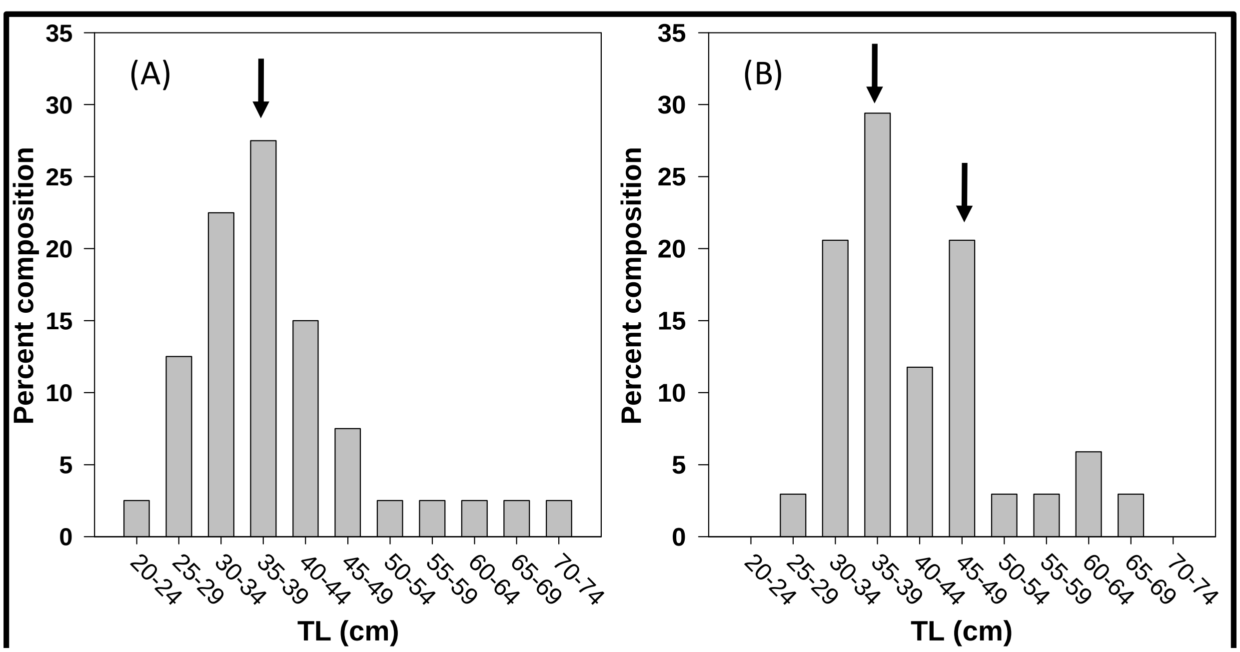


Figure 73. Percent composition histograms of juvenile gag populations on two live-bottom reefs: (A) Allegedly Reef (water depth,10 m; distance offshore, 13 km); (B) Turtle Tower (water depth, 15 m, distance offshore, 20 km). Allegedly Reef appears to be dominated by age class 1 fish whereas Turtle Tower appears to be dominated by age class 1 and 2 fish (arrows denote age classes).

production model developed at GCRL during NGI year 1-3. The model is currently being used to address the effects of static (emergent vegetated marsh) and dynamic (e.g., temperature, salinity, dissolved oxygen) habitat variables on fish production. We are expanding on this effort by conducting a comparative field and modeling study between the Pascagoula River, MS and Apalachicola Bay, FL during NGI year 4-5. This comparison includes field measurements of both static and dynamic habitat variables in a particularly important juvenile fish nursery habitat (East Bay) of the larger Apalachicola River estuary as model input, and a side-by-side comparison of model performance between the two systems. The field effort uses a combination of small trawl, beach seines, and hydrographic measurements to quantify habitat variation in parallel with ongoing sampling at GCRL. Our objectives are to obtain a functional model of the relationship between habitat variability and fish production for East Bay, the relationship between habitat conditions and juvenile fish production in this particular nursery habitat and that of the larger Apalachicola Bay system, and an assessment of the extent to which a common model framework can be applied across distinct coastal ecosystems in different regions of the Gulf of Mexico. **See Milestones.**

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 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.

Two main factors are currently expected to influence the NEGOM ecosystem: (1) the Deep Horizon oil spill and associated environmental and ecological damages, and (2) coastal development with itinerant increases in nutrient concentrations. Our project has value in terms of the calibration of models of the larger scale circulation and dispersion of surface and shallow surfactants in the near-coastal zone, and the inclusion of physical components such as waves that are at present not represented in the models.

Increased nutrient concentrations in the coastal zone promote 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 NEGOM, shelf currents undergo seasonal changes as the net surface heat flux changes between cooling to warming (Morey 2002). 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 NEGOM produce a 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. Presently we are concentrating on the role of tidal transport on the oxygen distribution, particularly at site A, where strong east-west advection in the sound can sweep properties including oxygen and other material back and forth from the bay to the sound and in and out of the gulf (Figure 74 and Figure 75).

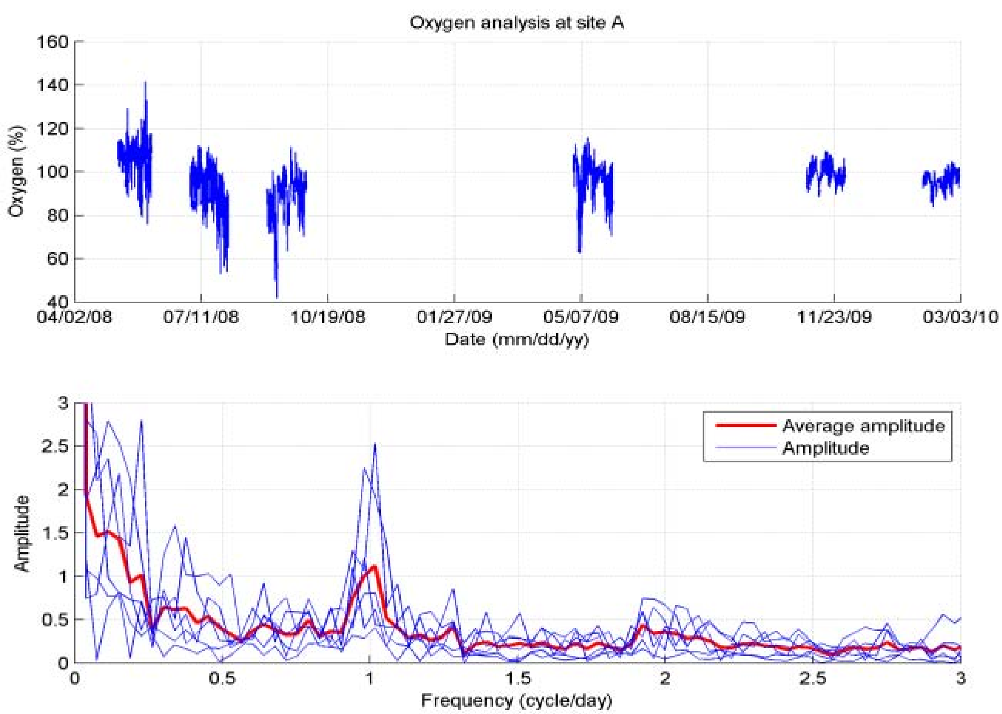


Figure 74. Analysis of oxygen time-series at 6 different periods during the year. Periods used are spread across 2008-2009-2010 (upper). Frequency analysis (lower) shows the dominant diurnal cycle and possible undertones due to the lengthening and shortening of the day, but also a marginally significant peak at nearly double the diurnal period, suggestive of a tidal advection signal.

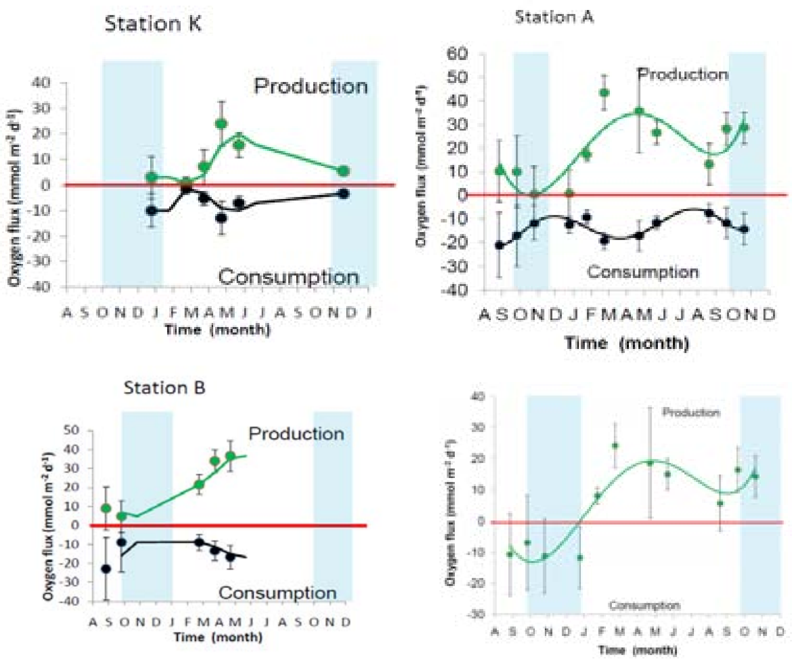


Figure 75. Benthic production and consumption rates measured at the sites of our Gulf transect at depth of 5 m (Station A), 10 m (Station B) and 18 m (Station K). High production rates are associated with high consumption rates. During winter, the benthic environment can be heterotrophic while during the rest of the year, the system shows and autotrophic character.

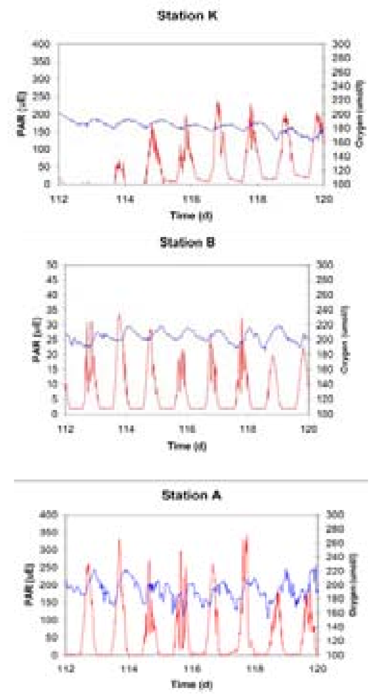


Figure 76. Oxygen concentration oscillations in the benthic boundary layer at the three sites along the K-Tower transect.

Mixing and water column productivity, sediment transport and benthic productivity: We continue measuring water column and benthic productivity along the transect, correlating productivity data with 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 $m^2 s^{-1}$ (Ohlmann and Niiler 2005). The land-derived nutrients boost primary production in the coastal zone, and the

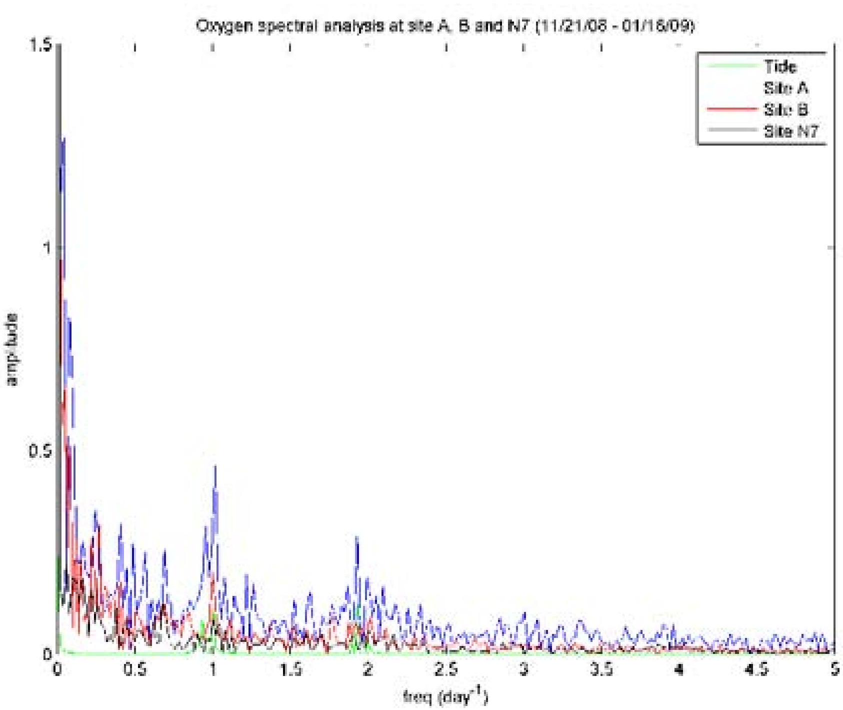


Figure 75. Spectral analysis of the oxygen time-series at site A, B, and the tower showing stronger signals close to the M2 tidal period at site A, presumably due to lateral advection. For comparison the pressure spectrum is shown (green). Confidence levels are barely significant however, and these signals are presently being tested in other ways, and compared to direct advection estimates.

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 re-suspension, and turbidity data provide data for assessing reliability of these estimates. Productivity measurements based on oxygen production/consumption rate measurements (Figure 73 and Figure 74) are 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).

Along our study transect, high benthic production rates are associated with high consumption rates. During winter, the benthic environment can be heterotrophic while during the rest of the year, the system shows and autotrophic character. The measured rates compare in magnitude to those reported from environments with organic rich muddy sediments, emphasizing the high activity of the NEGOM sands and the role of advective sediment flushing in boosting the production and consumption rates. Interestingly, we observed a high degree of autotrophy in these sediments, i.e. they produced more than they consumed, suggesting that these sediments are a significant source of organic matter for the benthic food chain in the near shore Gulf. This high benthic activity is also reflected in the oxygen oscillations measured at all three stations, which show a diurnal cycle of oxygen oscillation that is tightly linked to the light cycle. During daytime, production of oxygen increases until sunset and the decreases until sunrise. These oscillations are caused by photosynthetic production and microbial consumption processes of sediment and overlying water. The contribution of the sediment to these oscillations in the water column is 2 to 10%. The oscillation provides triggers for the benthic food web and through associated redox oscillations accelerated organic matter degradation rates.

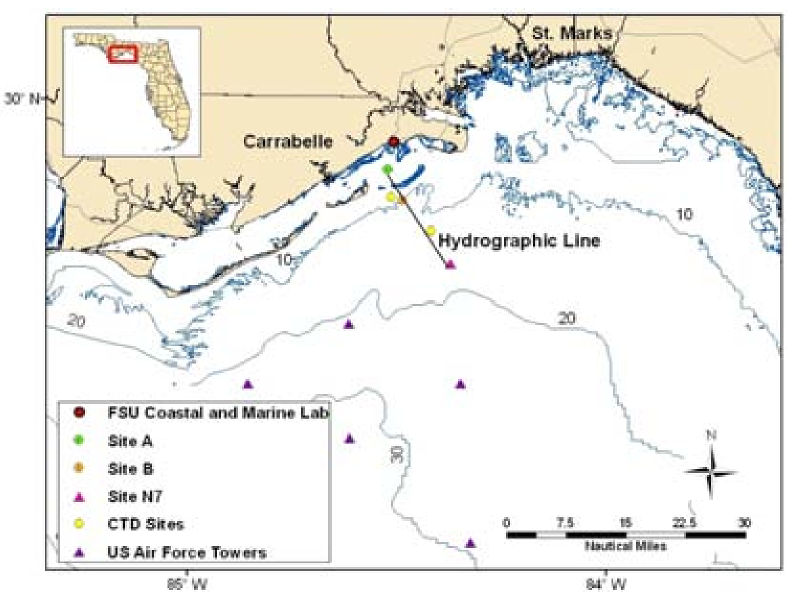


Figure 78. Map of the Big Bend Region, Florida and the FSU NGI Observing System just offshore of the FSU Coastal & Marine Lab

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 mount 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: 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 re-suspension 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 concentra-tions at the study site (e.g. show whether advection of low-oxygen water or a local sediment re-suspension event cause oxygen depression). The 17 NM transect extending from the United States Air Force (USAF) tower N7 to within 3 NM of shore has monitoring instrumentation deployed at three depths -- 5m (A), 10m (B), and 20m (N7) (Figure 78). Instrumentation is serviced and data downloaded ~monthly at all sites (see White et al., 2009). A multi-parameter YSI 6600 EDS located at each site measures at 15 minute intervals the temperature, conductivity, pH, turbidity, chlorophyll, dissolved oxygen, Photosynthetic Active Radiation (PAR), and depth. A Nortek Acoustic Wave and Current Meter (AWAC) deployed at site A and B measures waves every hour. N7 hosts 2 Sea-Bird 16 SEACAT's at 3 m (top) and 9 m (mid) depths that measure conductivity and temperature (CT) every 15 min in real time. Approximately 500 feet SW of tower N7, is a Teledyne RDI Acoustic Doppler Current Profiler (ADCP), a multi-parameter YSI 6600 EDS, a Wet Labs ECO Fluorometer. The instruments are attached to a MSI trawl-proof saucer bottom mount.

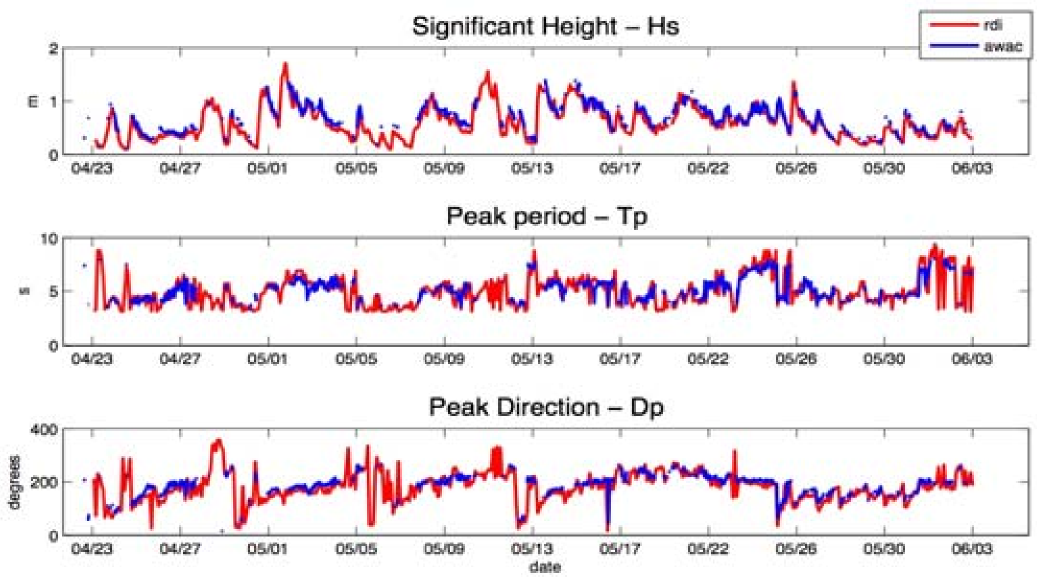


Figure 79. Comparison plot of the RDI and Nortek AWAC wave results. Note that these quantities are the output of proprietary software processing routines. Fewer AWAC data points are plotted only because the AWAC software flags more values than the RDI software, but total effective data return is actually greater with the AWAC.

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, mounted in identical MSI trawl proof saucer bottom mounts, approximately 500ft apart. Results (Figure 79) 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.

We are currently implementing the telemetry of the oceanographic instrumentation at Site N7. The RDI ADCP, YSI, and eventually CDOM sensor 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 has bench tested all the instruments with the Campbell-Scientific data logger and will deploy as soon as the cable layers are ready and deployed. 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 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.

The COAPS data center developed and implemented an automated data management system that collects, formats, quality controls, and distributes the near real-time surface marine meteorology data from Site N7. The system stores metadata on instrumentation and platforms, merges multiple files transmitted from tower-to-shore on 10-minute intervals to create a complete daily file, and tracks progress of the daily processing (Rettig et al. 2009). All data are managed and distributed via a web interface (http://coaps.fsu.edu/ngi/home/). The daily quality-controlled meteorology data are available at http://coaps.fsu.edu/ngi/data_availability.php. Here a user can select a desire date range, view the overall quality of the data for that day, and uses drill-down graphics to determine which parameters were assigned quality control flags. In addition to the daily files, real-time meteorological and upper ocean (temperature and salinity) data are provided when each transmission is received from the tower (10 min. intervals for atmosphere, 15 min. for ocean).

These data are used to evaluate the potential for deploying offshore wind power generators in the NEGOM, using funds external to the NGI. Preliminary analysis reveals the existence of a wind power resource in the region. Extension of the NGI instruments to other offshore towers will further support offshore wind research.

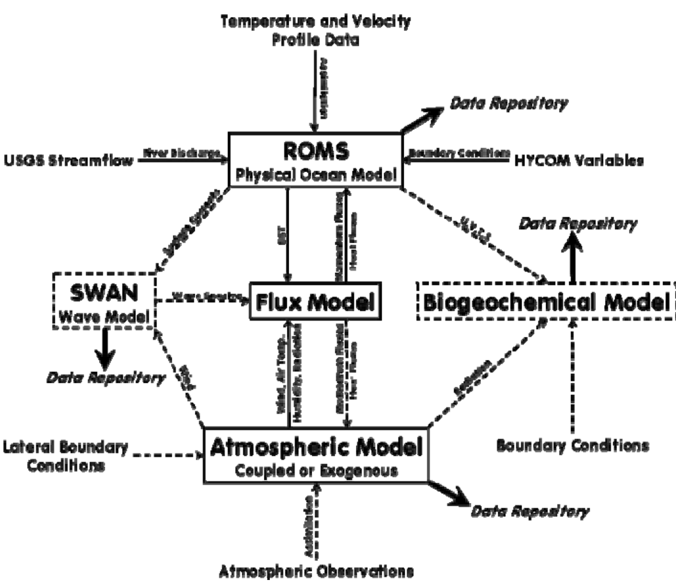


Figure 80. Schematic of the coupled modeling system. (1) ROMS is configured at 30 arcsec horizontal resolution and 25 vertical layers.

Modeling Component

The purpose of this modeling component is to develop a set of numerical tools to support interdisciplinary marine and atmospheric research in the NEGOM 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 80).

There are a number of different components of the modeling system:

(1) *the Regional Ocean Modeling System (ROMS)*, the central component that simulates the BBR (Figure 81) and is being used to investigate circulation patterns that can transport larvae of reef fish spawned offshore to the nearshore seagrass beds that serve as their nursery grounds. This model is nested within the HYbrid Coordinate Ocean Model (HYCOM) ocean prediction system (http://www.hycom.org), and is forced by 3-hourly atmospheric model data input to the COARE 3.0 flux algorithm and discharge from 15 local river sources. Lagrangian particle tracking methods indicate that larvae released from known offshore spawning sites in the late winter/early spring can reach the seagrass beds within a two-month time frame at either the ocean bottom or ocean surface, but with significant interannual variability (Figure 82). This realistically tracks pelagic larval duration. Model variability is linked to the interannual modulation of atmospheric synoptic scale forcing [*Morey et al.*, 2010].

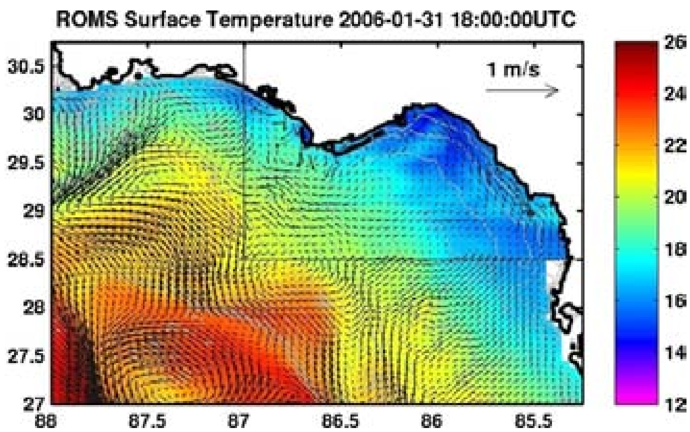


Figure 81. The ROMS BBR model surface temperature and currents for the 31 January 2006 hindcast nested within the 1/16° global HYCOM. The ROMS model domain is indicated with the black box.

The biophysical Lagrangian particle tracking utility LTRANS provides more realistic three-dimensional particle tracking with the possibility of incorporating larval behavior.

(2) *The atmospheric component of the modeling system* is being used to examine nearshore sea breeze circulation and air-sea fluxes during cold air outbreaks over the region. The model 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 S. E. U.S. domain, which is in turn nested within the 12 km North American Mesoscale WRF model. 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 S.E. U.S.

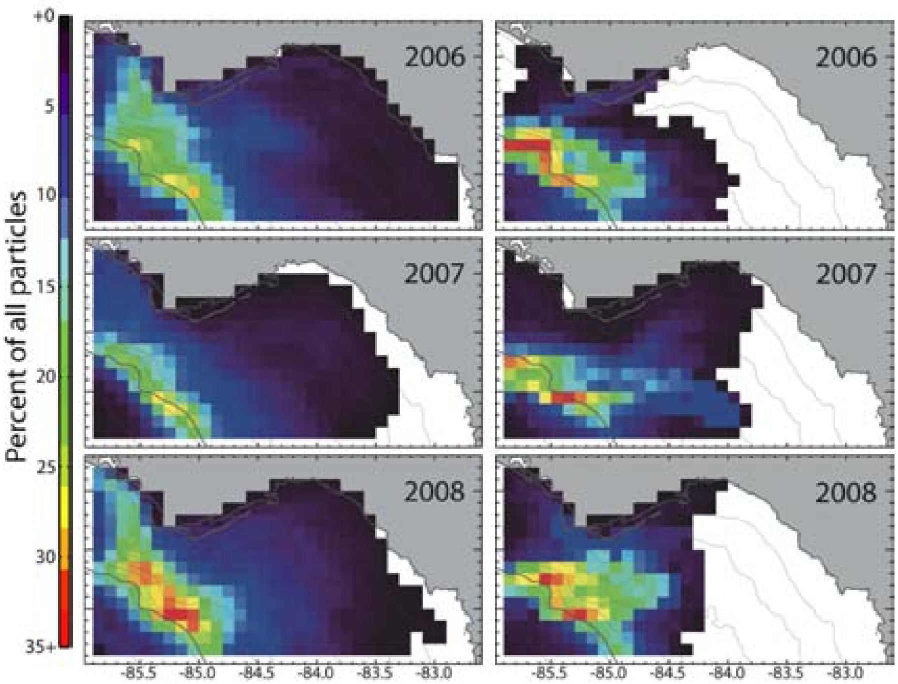


Figure 82. Near-bottom particle trajectories (left) and surface particle trajectories (right) calculated from the ROMS BBR simulation. Particles are released along the 80m isobath (bold contour line) every three hours for twelve weeks and are followed for a maximum of 45 days. Colors indicate the percentage of released particles that ever pass through a location (.1° x .1° bin) during their lifetime.

(3) *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 is being used to investigate the potential role of Stokes Drift as an onshore transport mechanism for larvae. It 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. Results from the coupled ocean – wave modeling system are being validated against NGI observations. The fully coupled modeling system is being implemented using the COAWST (Coupled Ocean – Atmospheric – Wave – Sediment Transport) modeling system that incorporates ROMS, WRF, and SWAN. Researchers have collaborated with the local NOAA NWS office for implementation of a realtime operational wave forecast model for the region.

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Journal of Physical Oceanography 1982 12:11, 1310-1317 Morey, S.L., M. Bourassa, and A. Todd (2010), Interannual variability of synoptic scale winds over the northern West Florida Shelf from SeaWinds and ASCAT, 2010 International Ocean Vector Winds Meeting, Barcelona, Spain.

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Nelson, J. A., J. P. Chanton, F. C. Coleman, and C. C. Koenig. 2010. Patterns of stable carbon isotope turnover in gag, Mycteroperca microlepis, an economically important marine piscivore determined with a non-lethal surgical biopsy procedure. Environmental Biology of Fishes.

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Stallings, C. D., Coleman, F. C., Koenig, C. C. & Markiewicz, D. A. (In press (2010)). Energy allocation in juveniles of a warm-temperate reef fish. *Environmental Biology of Fishes*.

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11. Outreach activities

Modeling Group

Morey, S. Speaking event, September 25, 2009, Florida A&M University Center for Water and Air Quality, "Apalachicola River Variability and Impacts on the Offshore Marine Environment", 25 people

Transport Group

We presented the NGI research of the Transport group at the FSU Science and Arts Fair in Tallahassee, April 17, 2010. This was a full day event where our NGI work was explained by our research group to the public with display of instrumentation, sediment samples, measuring techniques and data records.

Meteorology Monitoring Group

Ruscher, P. Presented results from tower observations at departmental seminar (fall 2009) and at National Weather Service Tallahassee Weatherfest (spring 2010)

Ecology Group

Training and mentoring of 6 senior-level undergraduate students; also participated in the NGI Diversity Internship with one intern from Puerto Rico

Todd, Austin. Seminar given at University of Maryland's Horn Point Laboratory (Horn Point, MD) on April 30, 2010, titled *Circulation dynamics and larval transport mechanisms in the Florida Big Bend*. This seminar was given as part of a visit to collaborate with the developers of the Larval TRANSport Lagrangian Model (LTRANS), currently being used for NGI research. Approximately 15 people from HPL attended the seminar.

12. Peer Reviewed Articles

Stallings, C.D., F.C. Coleman, C.C. Koenig, and D.A. Markiewicz. In press. Energy allocation in juveniles of a warm-temperate reef fish. *Environmental Biology of Fishes.*

Stallings, C.D. 2010. Experimental test of preference by a predatory fish for prey at different densities. *Journal of Experimental Marine Biology and Ecology* 389: 1-5.

Wilson, Rachel Marie, Jeffrey Chanton, Graham Lewis, and Douglas Nowacek (2010) Concentration-dependent stable isotope analysis of consumers in the upper reaches of a freshwater-dominated estuary: Apalachicola Bay, FL, U.S.A. *Estuaries and Coasts*. *Online First* (DOI: 10.1007/s12237-010-9304-3). In press.

Wilson, Rachel Marie, Jeffrey Chanton, Graham Lewis, and Douglas Nowacek. (2009) Combining Organic Matter Source and Relative Trophic Position Determinations to Explore Trophic Structure. *Estuaries and Coasts*. **32**:999-1010 (DOI: 10.1007/s12237-009-9183-7)

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

13. 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

Todd, A.C., and S.L. Morey, 2009: *Circulation and transport on the Northeastern Gulf of Mexico Shelf using a high-resolution ROMS model*, WGNE Blue Book 2009. Available online at: http://collaboration.cmc.ec.gc.ca/science/wgne/BlueBook/2009/individual-articles/08_Todd_Austin_todd_morey.pdf http://collaboration.cmc.ec.gc.ca/science/wgne/index.html)

White, S., K. Speer, N. Wienders, and M. Huettel (2009) Current Meter Facility Technical Report: Physical Observations in the Florida State University Northern Gulf Institute Program: Hydrographic Sections and Fixed Sites, 12 October 2009, Strozier Digital Archive.

14. Conference presentations and poster presentations for this project

Bourgoin, S.*, Thistle, D.*, Koenig, C.*, and Harter, S.^ Differences in the timing of settlement of gag, Mycteroperca microlepis, into seagrass meadows at the 100-km scale in the northeastern Gulf of Mexico. Given at the Northern Gulf Institute Annual Conference, May 18 – 20, 2010, Mobile, AL (*denotes FSU employee and ^ denotes NOAA employee)

Chassignet, E., S.L. Morey, A. Todd, D. Dukhovskoy, and M. Bourassa (2010), Use of a coastal ocean – atmospheric modeling and observing system to examine the variability of transport across the northern West Florida Shelf, 2010 AGU Ocean Sciences Meeting, Portland, OR.

Dukhovskoy, D.S. and S.L. Morey (2010). Modeling wave characteristics in the North Eastern Gulf of Mexico, ROMS Workshop, HI

Dukhovskoy, D.S., S.L. Morey, A. Todd and E. Chassignet (2009). Development and Applications of a Coastal Modeling and Monitoring System for the Florida Big Bend Region< SECOM-MABPOM Workshop, North Carolina State University, NC.

Huettel, M., Chipman, L., Laschet, M., Podgorski, D., Green, S., Kostka, J.E., Cooper, W.T. (2010). Dissolved organic carbon degradation in sublittoral sands. ASLO/TOS/AGU 2010 Ocean Sciences Meeting, 22-26 Feb., Portland, Oregon.

Kortessis, N., J.K. Craig, and S. Bosman. 2010. Environmental effects on food consumption of juvenile spot, Leiostomus xanthurus. Northern Gulf Institute Annual Meeting, Mobile, May.

Morey, S.L., M. Bourassa, and A. Todd (2010), Interannual variability of synoptic scale winds over the northern West Florida Shelf from SeaWinds and ASCAT, 2010 International Ocean Vector Winds Meeting, Barcelona, Spain.

Morey, S.L., and D. Dukhovskoy (2010), Ocean impacts of interannual variability in the Apalachicola River discharge, 2010 SECOM Meeting, Tallahassee, FL.

Morey, S.L., A. Todd, D. Dukhovskoy, and M. Bourassa (2010), Variability of Wind-Driven Transport in the Florida Big Bend Region, 2010 ROMS/TOMS Workshop, Honolulu, HI.

Nelson, J., Chanton et al. Florida Chapter of the American Fisheries Society, Ocala, Fl, 02/21/10

Nelson, J., Chanton et al. 95th Annual Ecological Society of America Conference, Pittsburgh, Pa, 8/1/10

Nelson, J., Chanton et al . 7th International Conference on Application of Stable Isotope Techniques to Ecological Studies, Fairbanks, Ak, 08/10/10

Rettig, J. Thesis Title: SAMOS/NGI Data Management System. Master of Science: *Computer Science*, December 2009, Florida State University, Tallahassee, FL. Advisor: Dr. Daniel G. Schwartz

Salvaterra, C, Mortensen E. one poster on currents and waves, and relation of oxygen to tidal flow in the Big Bend region**.**

Santema, M., Huettel, M., White, S., Speer, K. (2010). Contribution of Sandy Benthos to Photosynthesis and Respiration in the Northeast Gulf of Mexico.

Santema, M., Huettel, M., White, S., Speer, K., (2010). Temporal Dynamics of Dissolved Oxygen of the Benthic Boundary Layer in the West Florida Shelf. ASLO/TOS/AGU 2010 Ocean Sciences Meeting, 22-26 Feb., Portland, Oregon.

Stallings, C. was invited to give talks on previous research (i.e., non-NGI funded) but met with multiple faculty members and discussed NGI research at University of Florida, Dauphin Island Sea Lab, Western Washington University, and NOAA's Northwest Fisheries Science Center.

Taylor, MA, J.K. Craig, and J. Wanat. 2010. The foraging ecology of juvenile spot, Leiostomus xanthurus, in Apalachicola Bay, Florida. Northern Gulf Institute Annual Meeting, Mobile, May.

Todd, A.C., S.L. Morey, and E.P. Chassignet, 2010: *Circulation dynamics and larval transport mechanisms in the Florida Big Bend region* (Poster). Alpine Summer School on Buoyancy-driven flows 2010, Valsavarenche, Valle d'Aosta, Italy, June 21-30 2010.

Todd, A.C., S.L. Morey, and E.P. Chassignet, 2010: C*irculation dynamics and larval transport mechanisms in the Florida Big Bend region* (Talk). SECOM 2010, Tallahassee, FL, May 27 2010.

Todd, A.C., S.L. Morey, and E.P. Chassignet, 2010: *Understanding circulation dynamics and larval transport mechanisms in the Florida Big Bend region using a high-resolution ocean model* (Poster). Northern Gulf Institute Annual Conference, Mobile, AL, May 19-21 2010

Todd, A.C., S.L. Morey, and E.P. Chassignet, 2010: *Understanding circulation dynamics and larval transport mechanisms in the Florida Big Bend region using a high-resolution ocean model* (Poster). AGU Ocean Sciences, Portland, OR, February 2010.

Todd, A.C., 2009: *Understanding circulation dynamics and transport in the Florida Big Bend: An application to gag grouper larvae* (Talk). Florida State University Department of Oceanography Graduate Student Symposium, Tallahassee, FL, November 2009.

Wilson, Rachel M., Nowacek, Douglas P., Kucklick, John R., Balmer, Brian C., and Chanton, Jeffrey P (2009) Habitat utilization influences persistent organic contaminant concentrations in the blubber of bottlenose dolphins (*Tursiops truncatus*) from the Florida (USA) Panhandle, Poster Presentation at the Society for Marine Mammalogy's 18th Biennial Conference on the Biology of Marine Mammals in Québec City, Québec Canada. October 12-16th 2009.

15. Personnel from this project hired by NOAA during this reporting period:

None

16. NOAA Sponsor and NOAA Office the primary technical contact:

Julien Lartigue, NOAA Office of Oceanic and Atmospheric Research

APPENDIX A – SUMMARY COUNT OF PUBLICATIONS FOR NGI IN THIS REPORTING PERIOD

Summary of Publications for NGI					
		Year 1	Year 2	Year 3	Year 4
Peer Reviewed					
	Institute Lead Author	4	18	33	54
	NOAA Lead Author	0	1	1	1
	Other Lead Author	4	0	11	0
TOTAL		8	19	45	55
		Year 1	Year 2	Year 3	Year 4
Non-Peer Reviewed (not to include presentations)					
	Institute Lead Author	2	51	24	49
	NOAA Leader Author	0	11	1	9
	Other Lead Author	1	0	11	0
TOTAL		3	62	36	58

APPENDIX B – SUMMARY OF NGI SUPPORTED PERSONNEL FOR THIS REPORTING PERIOD

Summary of NGI Personnel Year 4				
Employees that receive > or = 50% NOAA Funding (not including students)				
Category	**Number**	**B.S.**	**M.S.**	**Ph.D.**
Research Scientist	43	10	23	10
Visiting Scientist				
Postdoctoral Fellow	8	0	0	8
Research Support Staff	1	0	1	0
Administrative	0	0	0	0
TOTAL	**52**	**10**	**24**	**18**
Students				
Undergraduate Students	16	16	0	0
Graduate Students	55	0	39	17
TOTAL	**71**	**16**	**39**	**17**
Employees that receive < 50 % NOAA Funding (not including students)				
Category	**Number**	**B.S.**	**M.S.**	**Ph.D.**
Research Scientist	107	9	26	72
Visiting Scientist				
Postdoctoral Fellow	5	0	0	5
Research Support Staff	8	3	5	0
Administrative	4	1	2	1
TOTAL	**124**	**13**	**33**	**78**
Located at Lab (name of lab) *	**14**	**10**	**2**	**2**
Obtained NOAA Employment			2**	2**

***NOAA Labs:** 1-Center for Coastal Fisheries and Habitat Research, 1-Estuarine Habitats and Coastal Fisheries Center, Lafayette, LA, 3- NOAA Fisheries Service, Galveston Laboratory, 1-NOAA-National Centers for Environmental Prediction, Environmental Modeling Center, 1-Northeast Fisheries Science Center, Narragansett, RI, 2- Southwest Fisheries Science Center, 1-National Marine Fisheries Services, Panama City Lab, 1-National Marine Fisheries Services, Southeastern Fisheries Science Center, Miami, FL, 2-National Coastal Data Development Center, 1-National Marine Fisheries Services, Southeastern Region, Pascagoula, MS Lab.

**Allison Odom has been hired by NOAA as a cooperative-student employee for the period of Jan 2010 to Jun 2011. She was supported by project 06-USM-07. Mr. Andy Millett was hired by NOAA/NMFS, Pascagoula, MS; effective Jun 2010. He was supported by project 09-NGI-11. Dr. Ronald Baker was hired on a short-term contract (Jun – Nov 2009) to further this and related work commenced during his NRC Post-Doctoral Fellowship with NOAA Fisheries in Galveston. He was supported by 09-NGI-MOD-18. Dr. Christopher Sinigalliano was hired by NOAA, as of Aug 2009. His duty station is the NOAA Atlantic Oceanographic and Meteorological Laboratory in Miami, Florida. He was supported by project 09-NGI-12.

APPENDIX C – LIST OF FIGURES